Virtual Learning

Physics

Newton’s Third Law of Motion

April 15, 2020

Physics

Newton's Third Law of Motion: April 15,2020

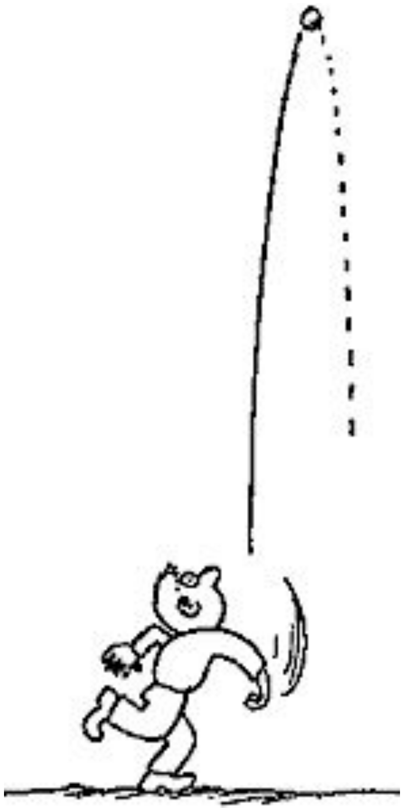
Objective/Learning Target:

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

Quick Review #1

A 1-kg rock is thrown at 10 m/s straight upward. Neglecting air resistance, what is the net force that acts on it when it is halfway to the top of its path?

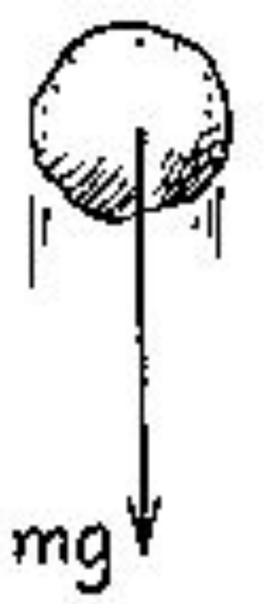
Draw a free body diagram to help explain your answer.



Quick Review Answer #1

In the absence of air resistance, the only force exerted on the 1-kg rock is simply the force gravity, mg.

That's 9.8 N downward, at any speed and anywhere along its trajectory.



Quick Review #2

Your empty hand is not hurt when it bangs lightly against a wall. Why does it hurt if you're carrying a heavy load?

Which of Newton's laws is most applicable here?

Quick Review #2 Answer

Using Newton's Second Law this answer becomes very simple.

The hand is coming to a stop in both scenarios, so acceleration remains constant.

So if $a = F/m$ then if the mass increases the force will also increase, if acceleration is to remain the same. If you are carrying a load then the mass that needs to stop is larger than when the hand was empty.

Newton’s Third Law of Motion

Link: **Newton's Third Law of Motion**

Directions:

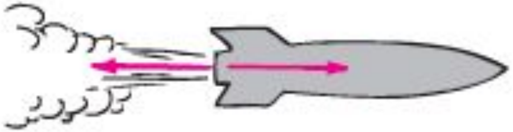
- Read through Newton’s Third law of motion; and,
- Work through any examples on a separate piece of paper before you scroll down to the solution.
- On a separate piece of paper complete the practice problems on the following slides.
- Check your answers.
- For additional practice check out the conceptual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

Practice Problem #1

For each of the following complete the action reaction pairs.

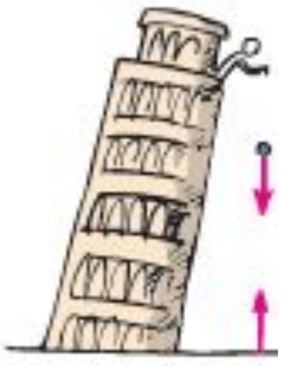
Action: Car pushes on road backward

Reaction:



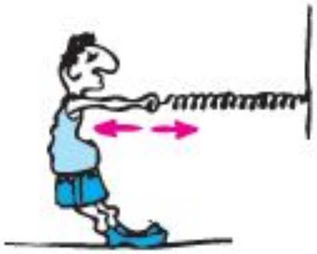
Action: Rocket Pushes gases backward

Reaction:



Action: earth pulling ball down

Reaction:



Action: man pulling on spring

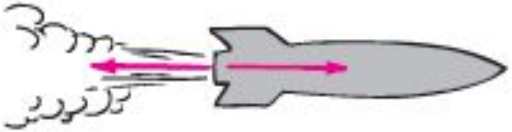
Reaction:

Practice Problem #1 Answer

For each of the following complete the action reaction pairs.

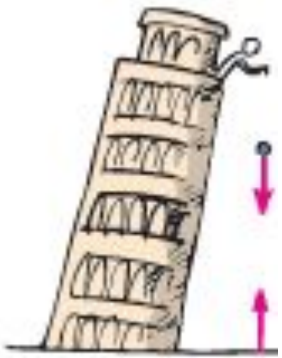
Action: Car pushes on road backward

Reaction: Road pushes car forward



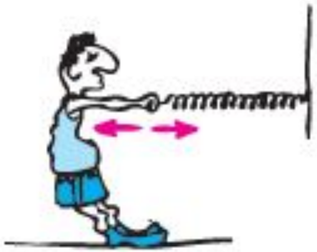
Action: Rocket Pushes gases backward

Reaction: Gases push rocket forward



Action: earth pulling ball down

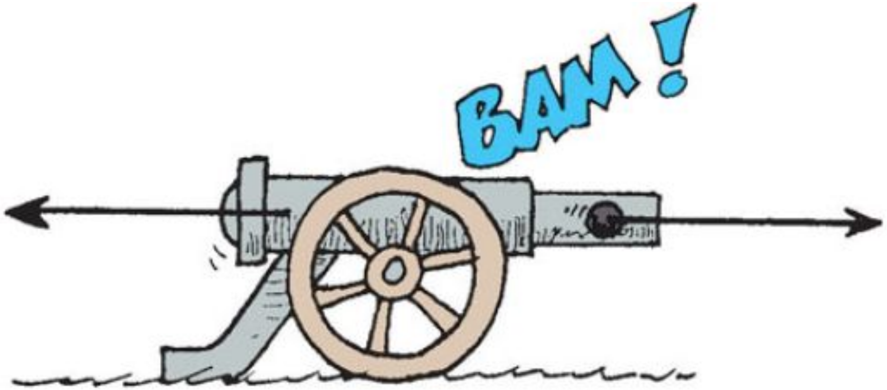
Reaction: ball pulling earth up



Action: man pulling on spring

Reaction: Spring pulling on man

Practice Problem #2



The force exerted against the recoiling cannon is just as great as the force that drives the cannonball inside the barrel(Newton's 3rd Law).

Using Newton's 2nd Law, explain why the cannonball accelerates more than the cannon?

Practice Problem #2 Answer

Newton's second law reminds us that we must also consider the masses involved. Suppose we let F represent both the action and reaction forces, m the mass of the cannonball, and M the mass of the much more massive cannon. The accelerations of the cannonball and the cannon are then found by comparing the ratios of force to mass:

$$\text{Cannonball}: \frac{F}{m} = \mathbf{a}$$

$$\text{Cannon}: \frac{F}{\mathbf{M}} = a$$

This shows why the change in velocity of the cannonball is so large compared with the change in velocity of the cannon. A given force exerted on a small mass produces a large acceleration, while the same force exerted on a large mass produces a small acceleration.

Practice Problem # 3

You stand next to a wall on a frictionless skateboard and push the wall with a force of 40 N.

a) **How hard does the wall push on you?**
b) **If your mass is 80 kg, how much would you accelerate?**

Practice Problem #3 Answer

a. Newton's 3rd law says if you push with 40N then the wall pushes back 40N.

b. Once we know the net force we can use Newton's 2nd Law to calculate the acceleration.

$$a = \frac{F_{net}}{M} = \frac{40N}{80kg} = 0.50\ N/kg = 0.50\ m/s^2$$

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.