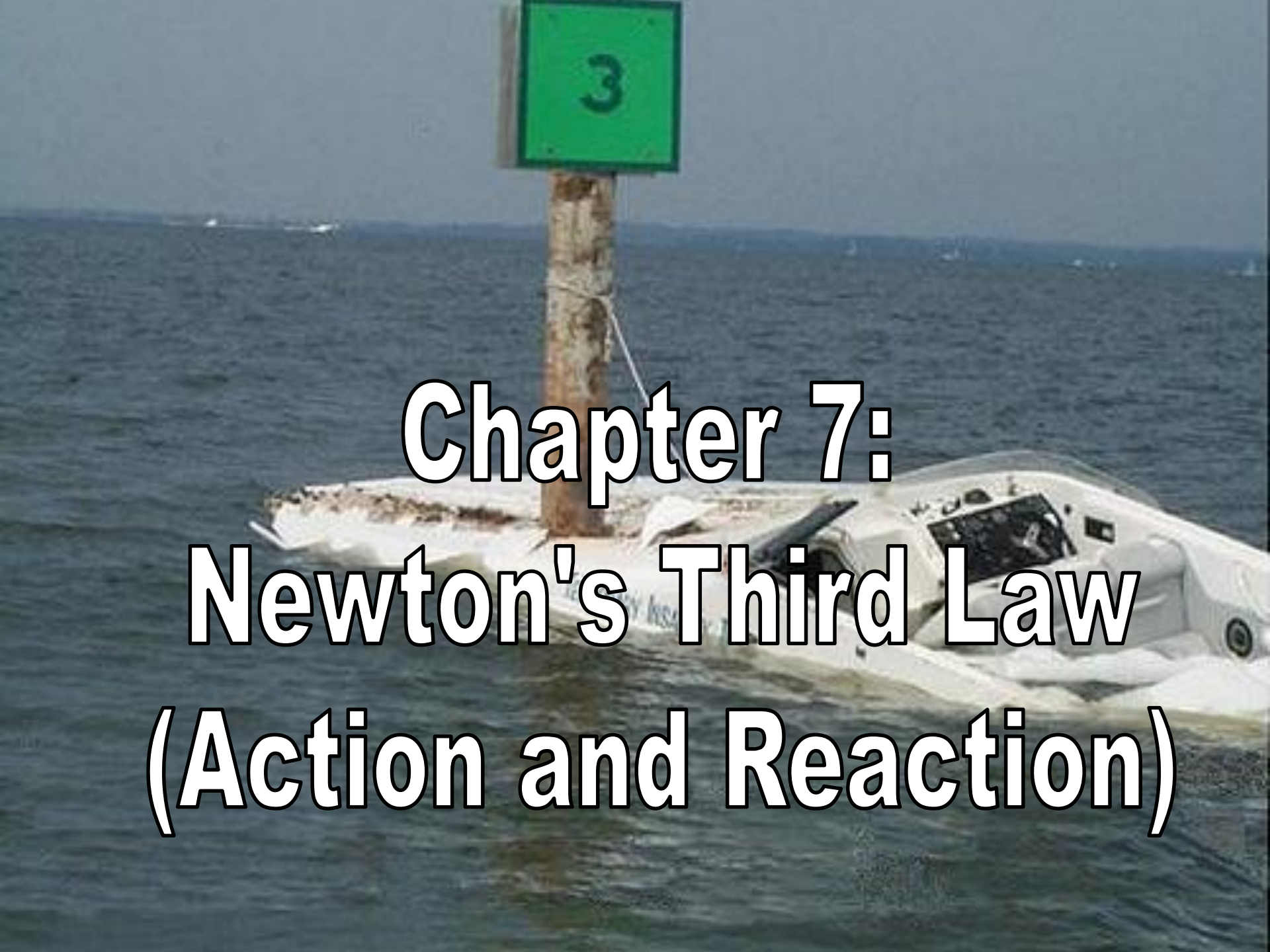


Chapter 7: Newton's Third Law (Action and Reaction)

Chapter 7: Newton's Third Law or Motion

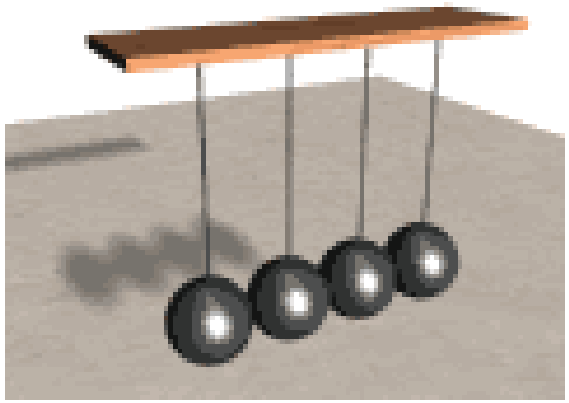
Action and Reaction

I. Forces and Interactions (7.1)

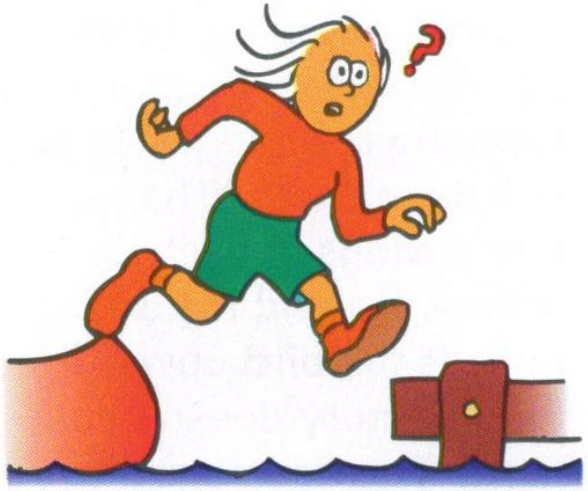
A. Force is part of a **mutual action**– an **interaction**

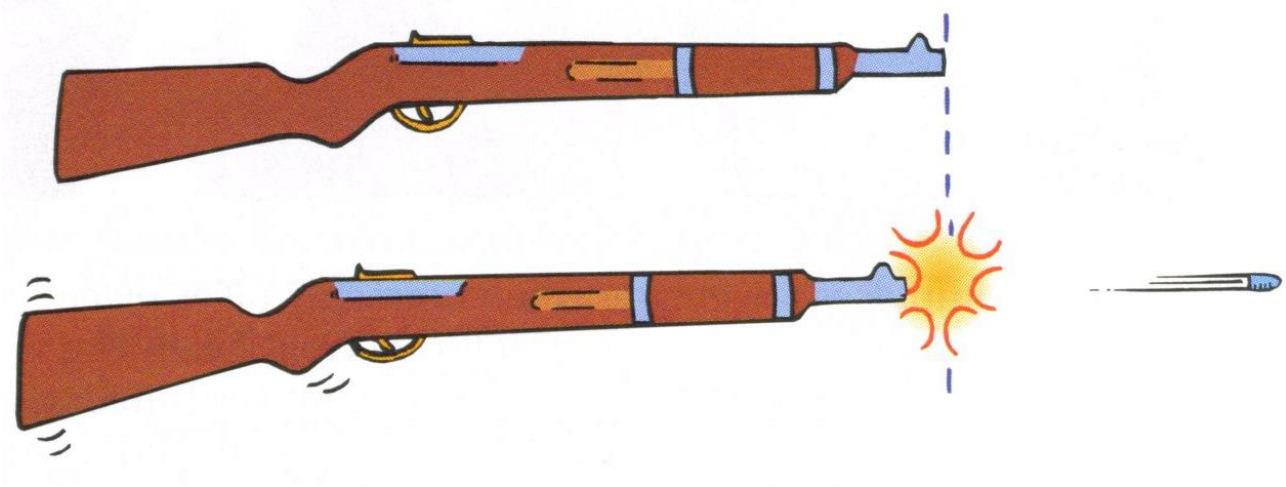
1. Acts between one thing and another

2. Each exert a force on the other object



B. Always a **pair** of forces– led Newton to his third law (law of action and reaction)

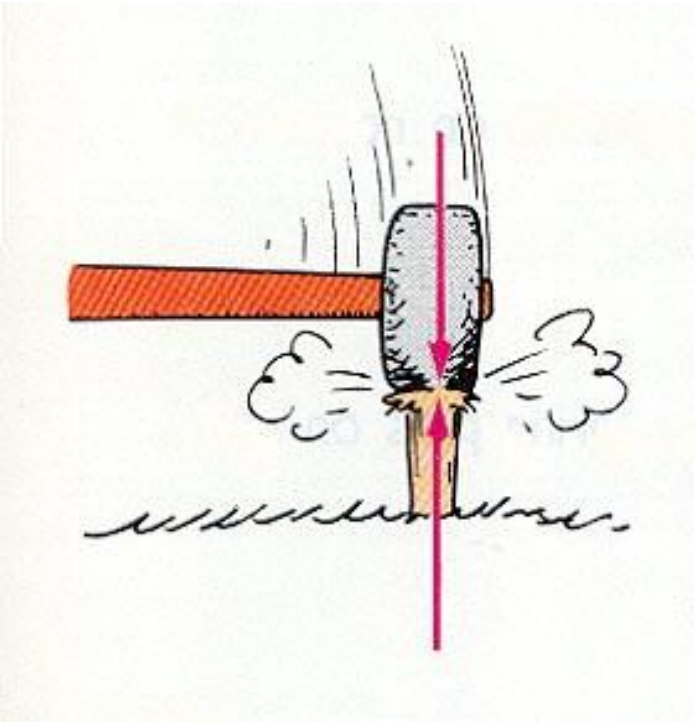




II. Newton's Third Law (7.2)

A. Third law states:

Whenever one object exerts a force on a second object, the second object exerts an equal and opposite force on the first object

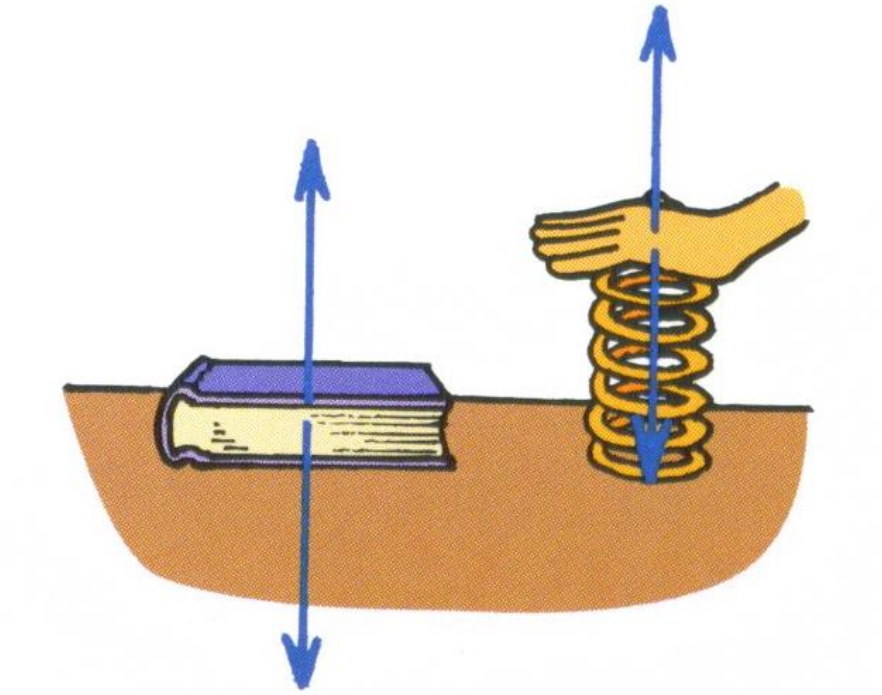


1. One force called **action force** and the other is called the **reaction force**

   a. It doesn't matter which we call action or reaction force

   b. They are "**partners**" in single interaction

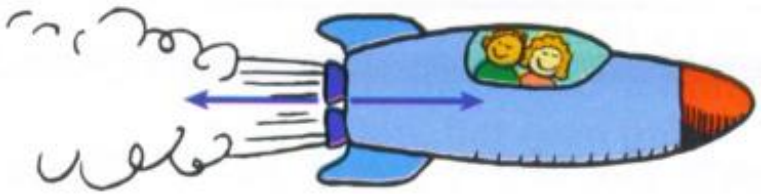
   c. Neither force exist without the other



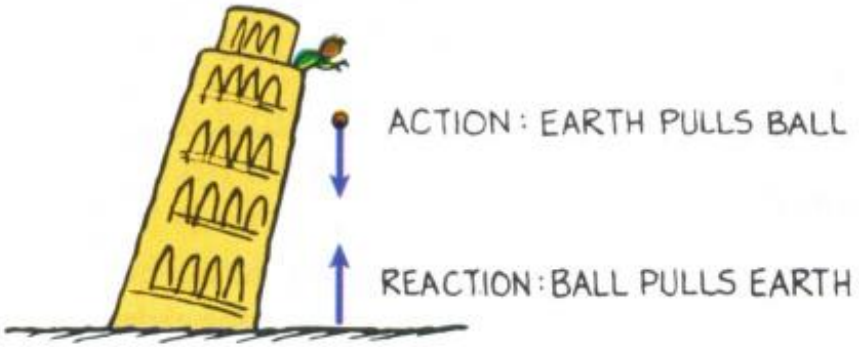
d. They are **equal in strength** and **opposite in direction**

("To every action there is always an equal opposing reaction")

ACTION : TIRE PUSHES ROAD REACTION : ROAD PUSHES TIRE

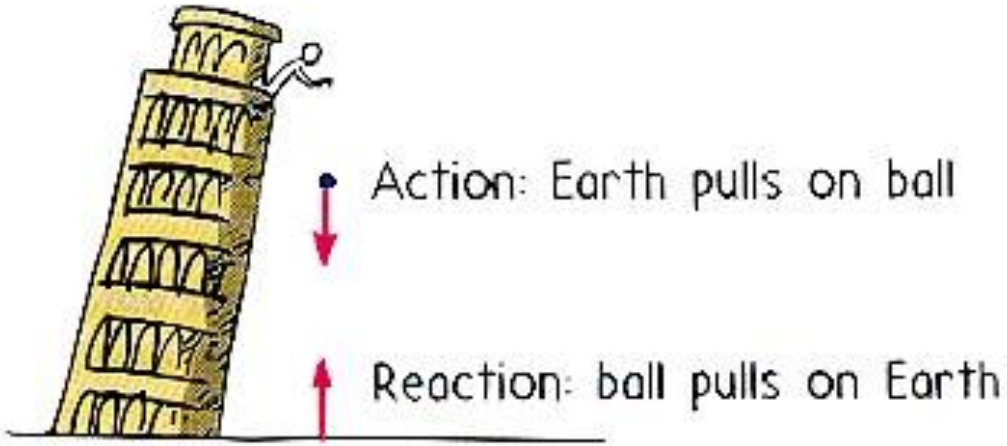


ACTION : ROCKET PUSHES GAS REACTION : GAS PUSHES ROCKET



B. Without the **action force** there cannot be **reaction force**

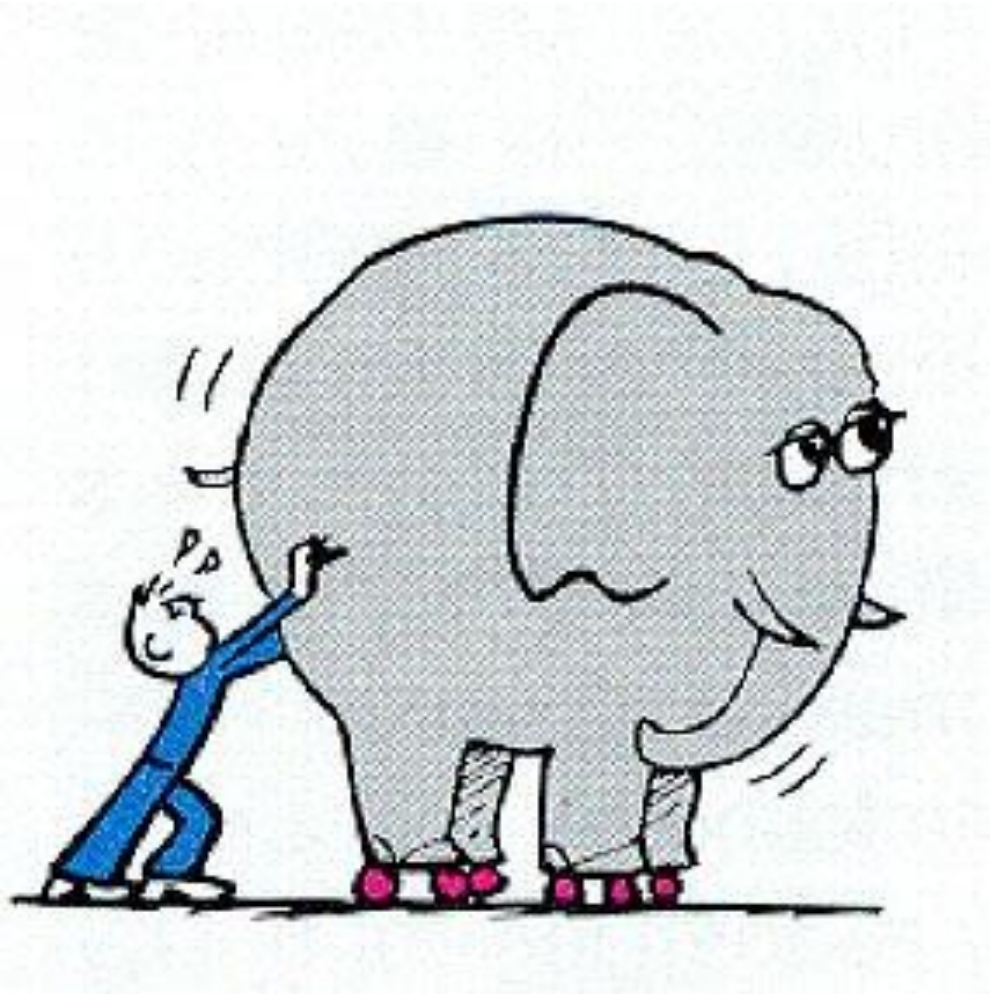
1. Thus **no** resulting **forward motion**
2. Forces include **contact** and **long-range forces**



III. Identifying Action and Reaction (7.3)

A. Identifying **action** and **reaction** pair

1. Can be difficult to identify sometimes



a. Start by identifying the **interaction** (e.g. Object A interacts with object B)

1). Action: Object A exerts a force on object B

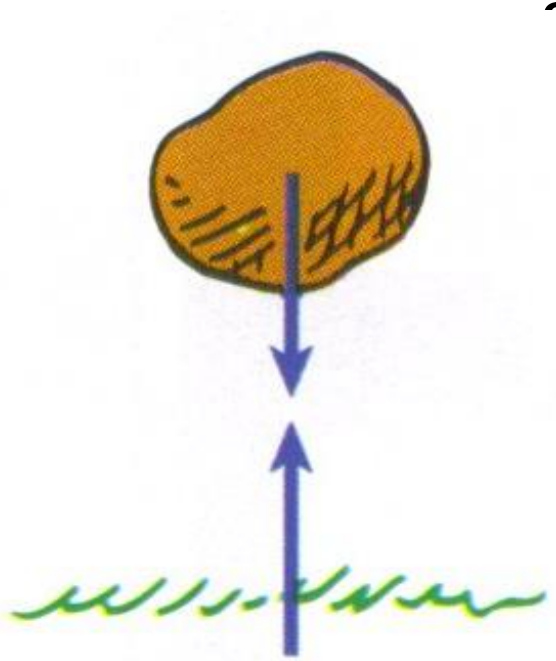
2). Reaction: Object B exerts a force on obje

IV. Action and Reaction on Different Masses (7.4)

A. Interaction between falling boulder and the Earth

1. Forces are **equal in strength and opposite in direction**

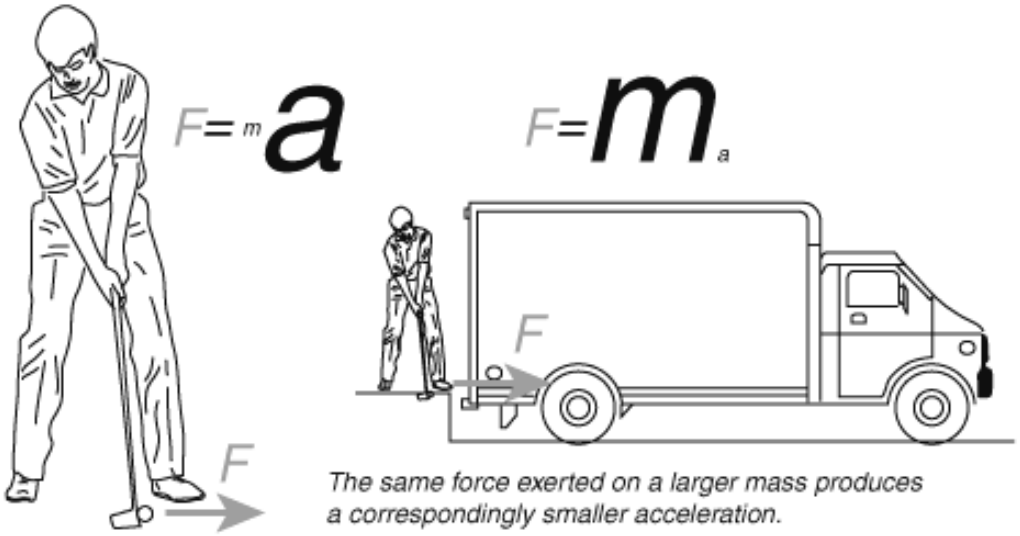
- Boulder falls to Earth
- Earth falls to boulder



2. **Forces** between Earth and boulder are **equal**, but **masses not**

a. **Newton's second** law states that **<u>acceleration</u>** is not only **proportional to net force**, but also **inversely proportional to <u>mass</u>**.

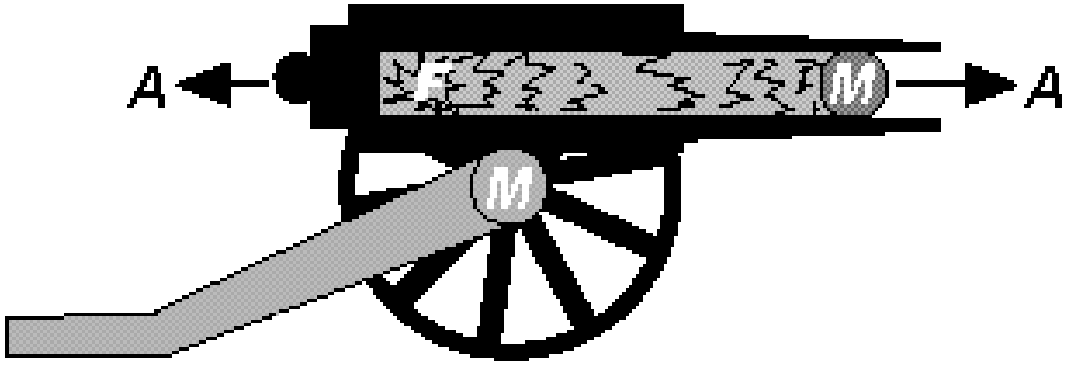
b. Earth's **large** mass– infinitesimally **small acceleration**



The same force exerted on a larger mass produces a correspondingly smaller acceleration.

B. Cannon example

1. Interaction between cannon and cannon ball is exactly equal in magnitude and opposite in direction
2. Must consider **Newton's Second law**



$$a = \frac{F}{m}$$

a. Cannonball

$$\frac{F}{m} = a$$

$$\frac{F}{m} = \mathbf{a}$$

b. Cannon

$$\frac{F}{m} = a$$

$$\frac{F}{\mathbf{m}} = a$$

$$F_{cannonball} = F_{cannon}$$

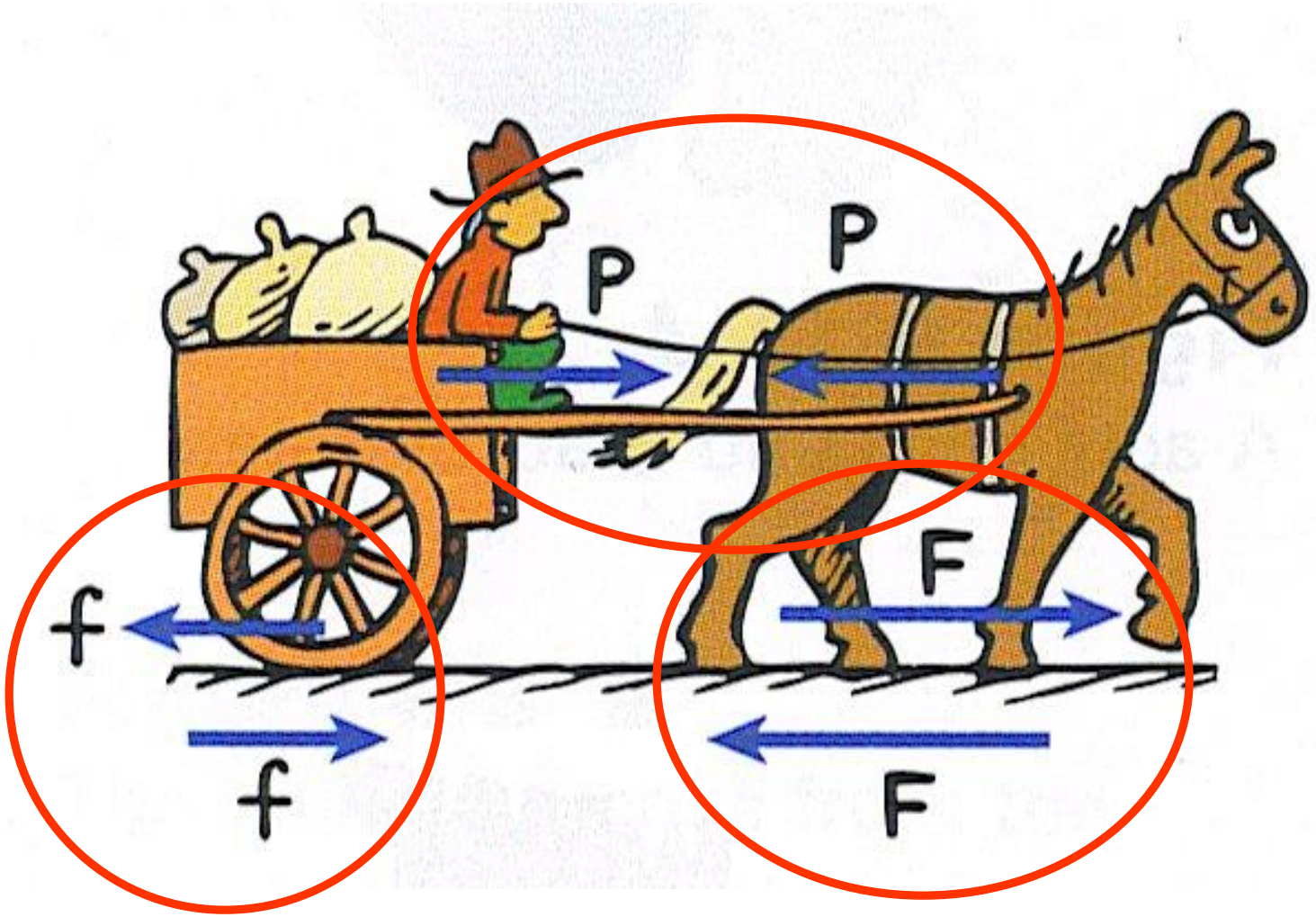
V. Defining Systems (7.5)

A. If action and reaction forces **are internal to a system**, they **cancel** each other and produce **no acceleration of the system**

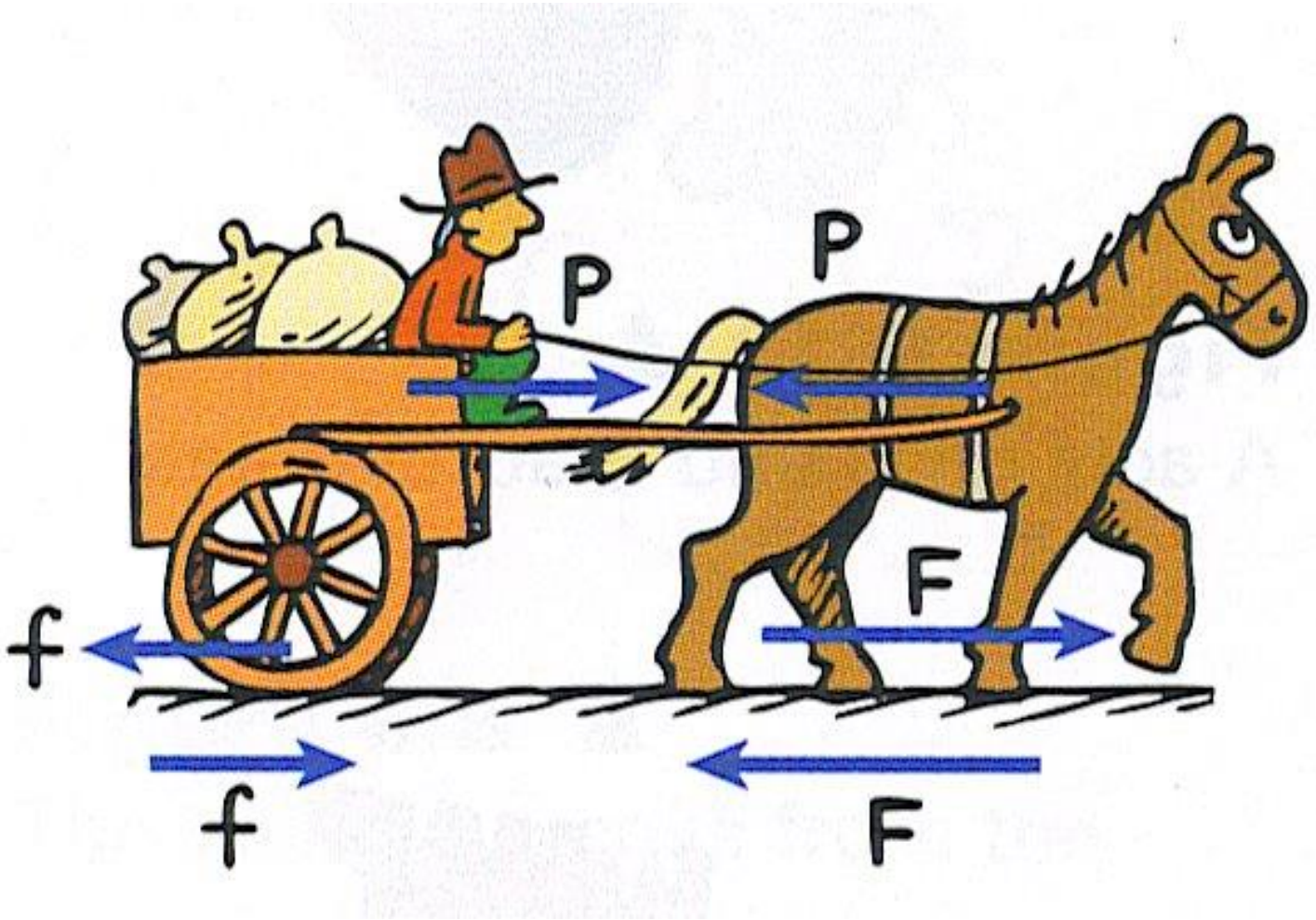
B. Action and reaction forces **do not cancel** each other when **either is external to the system** being considered.

VI. The Horse-Cart Problem (7.6)

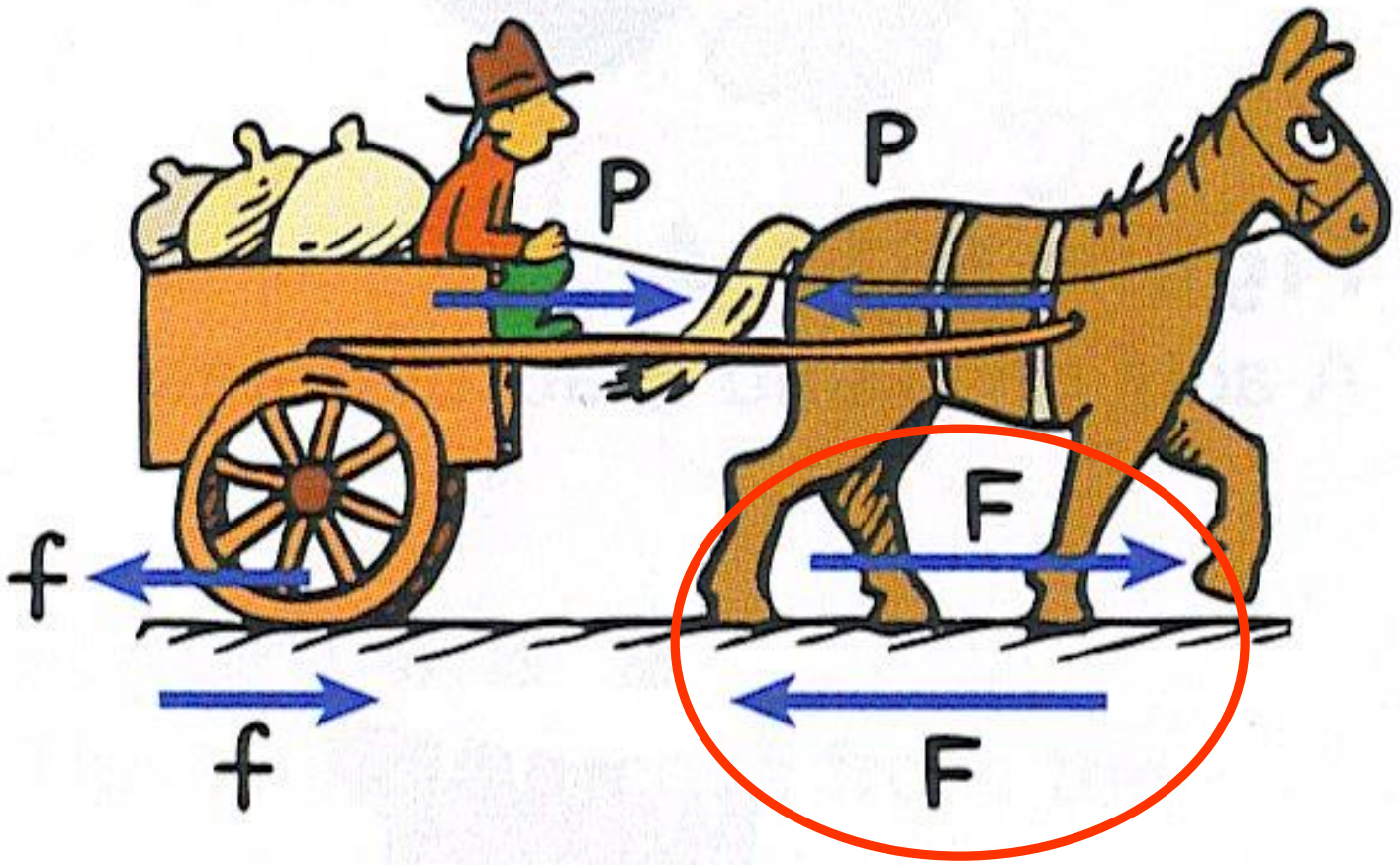
A. Can look at from three points of view



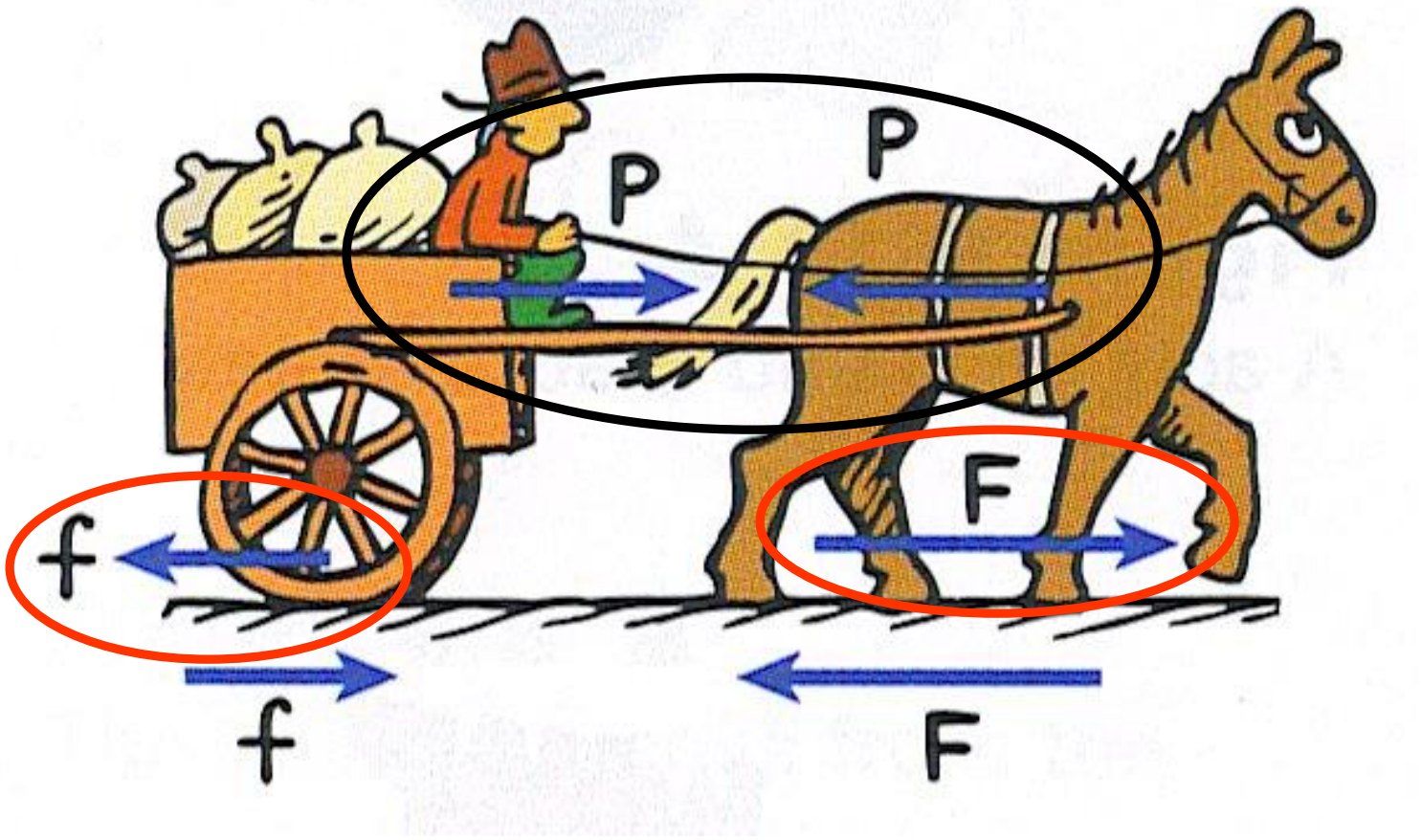
1. Cart system (net force exerted on cart divided by mass of cart = acceleration



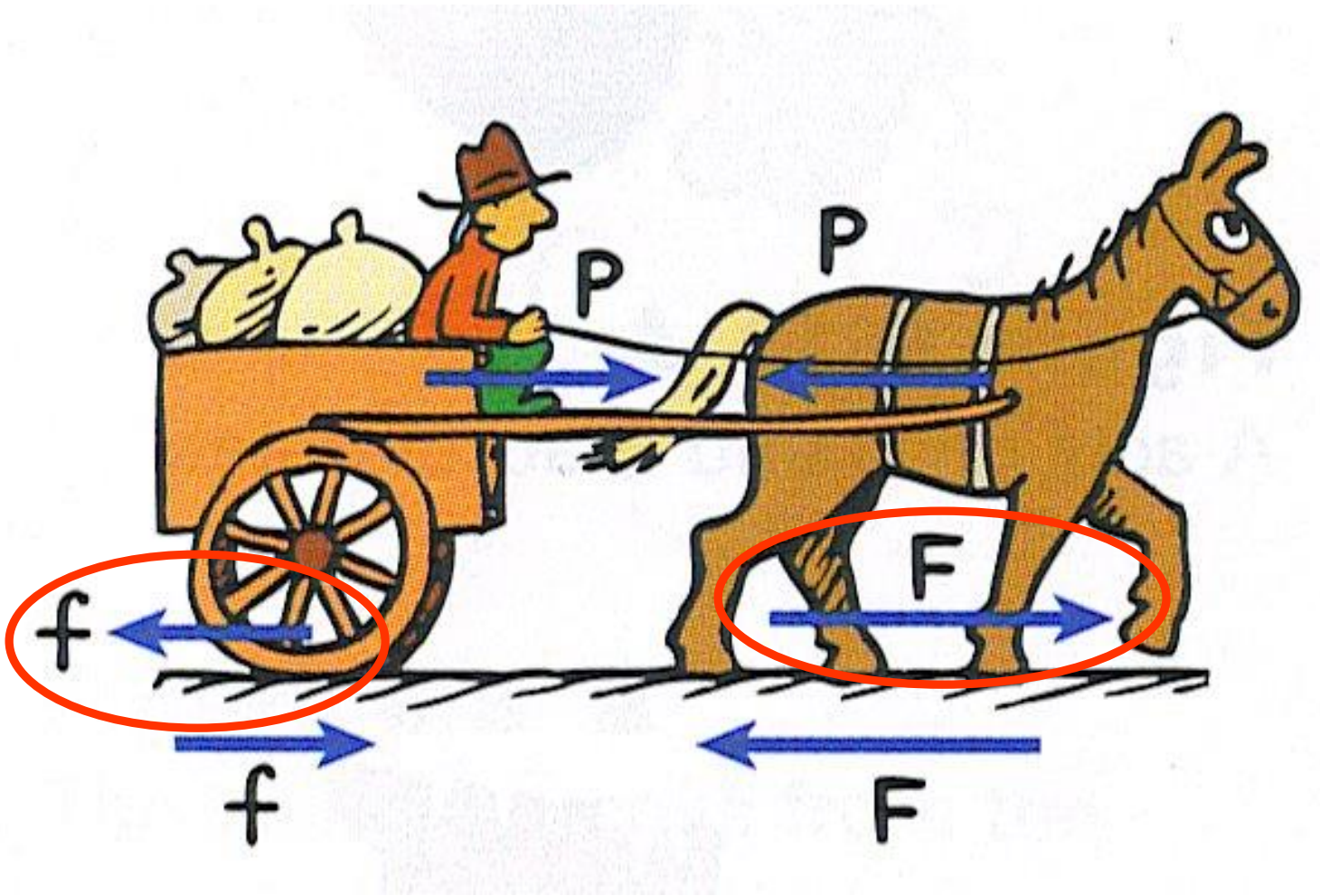
2. Horse system (horse moves forward by interaction with the ground– horse pushes backwards on the ground and the ground pushes forward on the



3. Horse-cart system (when consider only internal forces , forces that act and react within the system, they cancel. There must be interaction



Acceleration of horse-cart system due to net force of F - f



B. Stalled car example– you cannot move car forward by sitting in car and pushing on the dashboard. Must interact with the ground- make ground push car.

VII. Action Equals Reaction (7.7)– for every interaction between things, there is always a pair of oppositely directed forces that are equal in strength.