Flipping Physics Lecture Notes:
A Common Misconception about Newton's Thrid Law Force Pairs
(or Action-Reaction Pairs)

Newton's Third Law of Motion: $\vec{F}_{12} = -\vec{F}_{21}$

For every force object 1 exerts on object 2 there is an equal and opposite force object 2 exerts on object 1 where both forces are vectors.

From the Free Body Diagram of the book resting on the table: (Force Normal up and Force of Gravity Down)

$$\sum F_y = F_N - F_g = ma_y = m(0) = 0 \Rightarrow F_N = F_g \Rightarrow \vec{F}_N = -\vec{F}_g$$

- The book is at rest so the acceleration of the book in the y-direction is zero.
- $F_N = F_g$ is just the magnitudes of the two forces.
- From the Free Body Diagram we know:
  - The Force Normal is up and positive
  - The Force of Gravity is down and negative
  - Therefore: $\vec{F}_N = -\vec{F}_g$

The Force Normal and the Force of Gravity are equal in magnitude and opposite in direction; however, they are not a Newton's Third Law Force Pair because the two force act on the same object. Newton's Third Law Force Pairs always act on two different objects.

The Force Normal is the force the table applies upward on the book. Therefore, the Newton's Third Law force that makes the Force Pair with the Force Normal is the force the book applies downward on the table.

The Force of Gravity is the force the Earth applies downward on the book. Therefore, the Newton's Third Law force that makes the Force Pair with the Force of Gravity is the force the book applies upward on the Earth.