

### **Newton's Third Law : Apparent Paradox**

Consider a horse attempting to pull a wagon from rest on a rough surface. A student who misunderstood Newton's third law makes the following statement: "If the horse pulls forward on the wagon, then Newton's law of action-reaction holds that the wagon pulls back equally hard on the horse. Thus, the forces cancel and the system cannot be set in motion."

Explain briefly what is incorrect with the statement of this student.

### **Solution**

$\sum F = ma$  should be applied to one object at a time, whereas the forces mentioned here are applied on different objects: the horse and the wagon. If you want to determine the motion of an object, you must consider only the forces on that one object. The force that accelerates the system horse-wagon (seen as one object) is the force exerted by the ground on the horse's feet, which is the reaction to the force that the horse exerts backward on the Earth.