UNIT 5·5 Newton's Third Law

context A hose flicks about if it is turned on, its nozzle moving in a direction opposite to the water. The hose is pushing the water out, but the water is also pushing the hose back in the opposite direction. This is known as an **action/reaction** force pair.

A similar situation occurs whenever a weapon is fired. The weapon **recoils** (moves backwards) as the ammunition is shot. The explosion of gunpowder in a cannon will push a cannonball out (the action) and the cannon recoils because of the force the ball applies back on it (the reaction).

Newton's Third Law

Newton explains the action/reaction phenomenon in his **Third Law**:

> **For every action force there is an equal and opposite reaction force.**

The forces on both the cannon and the ball are the same (but in opposite directions) but their accelerations are very different. The ball has a relatively low mass and so has a high acceleration and therefore velocity. Having more mass, the cannon is much less affected.

In sport an action force is applied on a ball by a bat, racquet or foot. When you hit a golf ball, the club pushes the ball and is pushed back by it. The ball is light, so its acceleration is high. The club is much heavier and the force is usually only enough to slow, not stop, the swing. It might also cause a 'shudder' through the handle. You would feel reaction force even more if you played footy with a brick!

Worksheet 5.5 The history of forces

Summary: Newton's three laws

Newton's First Law

Any object at rest will stay that way unless a force acts on it. Any object that is moving will keep moving at the same speed and in the same direction unless a force changes it.

Newton's Second Law

If the forces on an object are unbalanced then its motion will change. The larger the force the bigger the change in motion. A change in motion is called acceleration and will depend on the mass of the object.

$$\text{force} = \text{mass} \times \text{acceleration}$$
$$F = m \times a$$

Newton's Third Law

For every action there is an equal and opposite reaction. That is, there is an action and reaction pair of equal and opposite forces, acting on a different object. The action and reaction forces never act on the same object.

NOTE: When speaking of an **action/reaction pair** of forces, there can be more than two forces involved but one group will be action forces, and the other group will be reaction forces.

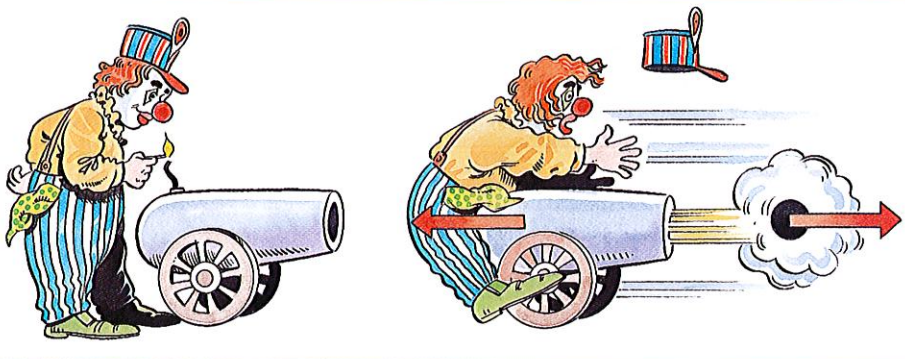

Fig 5.5.1 Weapons recoil due to Newton's Third Law.