

## Types of Force

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Mechanics is basically the study of the motion of physical bodies and the understanding of the **forces** that cause the motion. It is therefore important to understand the different types of forces which commonly occur in mechanics. The purpose of this leaflet is to explain these types.

### What is a force?

A force is an influence on a system or object which, acting alone, will cause the motion of the system or object to change. If a system or object at rest is subjected to a non-zero force it will start to move.

There are many different types of forces. They are all vector quantities (mechanics sheet 1.1). Forces that you encounter in mechanics are often referred to as mechanical forces. Some common forces are:

**Weight** Weight is a force caused (on Earth) by the gravitational attraction of a mass to the Earth's centre. The weight of a body, of mass  $m$ , is defined to be the force,  $\mathbf{W}$ , with which it is attracted to the Earth. On Earth,  $\mathbf{W} = mg$ , where  $g$  is the acceleration due to gravity ( $g \approx 9.81 \text{ m s}^{-2}$  on Earth).

**Tension** Many mechanics problems involve objects being pulled, pushed or suspended from a string, spring, rod or something similar. The force that the string (or similar) exerts on the object in these types of problems is called tension.

**Resistive Forces** These include:

**Friction** which is a force that prevents, or tries to prevent, the slipping or sliding of two surfaces in contact.

**Air Resistance** which acts in the opposite direction to the motion.

**Normal reaction force** A mass lies on a horizontal surface as shown in the diagram. The weight of the mass pulls it downwards. The reason it does not fall is because the horizontal surface exerts an equal and opposite force on the mass called the *normal reaction force*, usually denoted by  $R$ . (See Figure 1)

### *Normal reaction force*

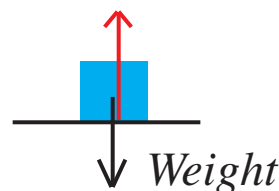


Figure 1

### Note:

*The normal reaction force always acts perpendicularly to the surface that is causing it.*

### Worked Example 1.

A block lies at rest (not moving) on a rough inclined slope; what forces act on the block?

#### Solution

The *weight* of the block acts vertically downwards. The slope exerts a *normal reaction force* on it perpendicular to the slope. In the absence of any other force the block would slide down the slope. However, the block is at rest so there must be another force acting. This force is *friction* and since the block 'wants' to move down the slope the friction force must be acting up the slope. (Fig. 2)

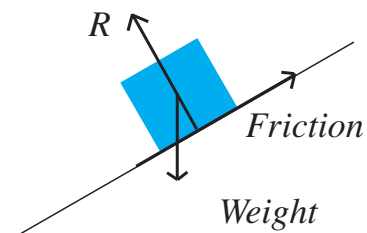


Figure 2

### Worked Example 2.

A ball, attached to the ceiling, is swinging on the end of a string in a simple pendulum motion; modelling the ball as a particle, what forces act on it?

#### Solution

The *weight* acts vertically downwards on the particle. The *tension* in the string that the particle is suspended from pulls along the line of the string at any instance. These forces are shown in Figure 3.

Figure 3 also shows the velocity. This is **not** a force, it is a quantity that describes the motion of the mass but does not affect the motion.

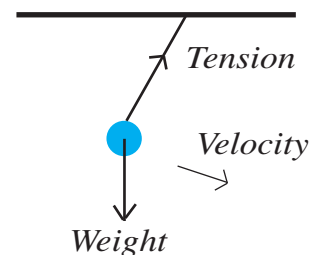


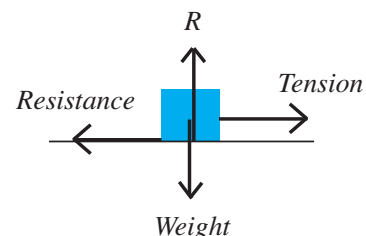
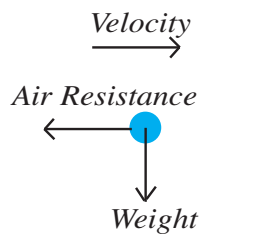
Figure 3

#### Exercises

Drawing a diagram will be helpful in solving these problems (see mechanics sheet 1.6).

1. A ball is thrown. What forces act on the ball, when it is travelling horizontally?
2. What forces act on a trailer attached to a tow rope being pulled by a car?

#### Answers



1. The *weight* acts vertically downwards on the ball. The only other force that might be acting is *air resistance* which will act in the opposite direction to the motion of the ball.
2. The trailer will be pulled by a *tension force* from the tow rope connecting the car to the trailer. The *weight* acts vertically downwards on the trailer. There will be a *normal reaction force* from the road on the trailer acting perpendicularly to the road. The road will not be a smooth surface so there will be a *resistive force* that will act against the direction of motion of the trailer.