4.5.1 Drawing free body diagrams and F=ma

videos

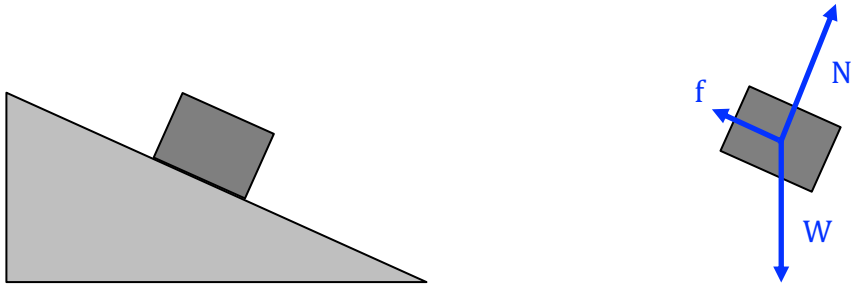
Isaac Newton gives his name to 3 laws of motion:

1) An object either remain at rest or moves with a constant velocity unless acted on by an unbalanced force.
2) An unbalanced force acting on an object will cause it to accelerate in the direction of the force. This acceleration is directly proportional to the unbalanced force and inversely proportional to the mass of the object. This is expressed by the equation F=ma (*where F=unbalanced force, m=mass of object, a=acceleration*).
3) If object A exerts a force on object B, then object B exerts an equal and opposite force on object B.

Laws 1 and 2 deal with objects in isolation, whereas 3 deals with 2 objects interacting.

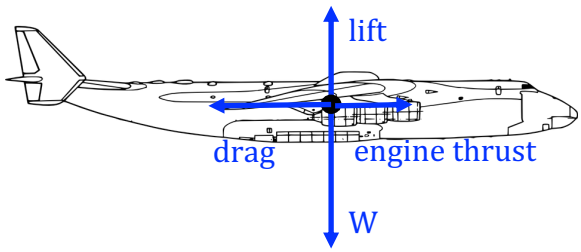
Free body diagrams

Because laws 1 and 2 deal with an individual object, it is often useful to draw an individual object and the external forces that are acting on it.
Here is an example:



In this case we have a block on an inclined surface. On the right hand side, we have the free body diagram of the block, with only the block drawn and the external forces acting on it. In this case the forces are W=weight, N=normal reaction (reaction force from the inclined plane), and f=friction. If we found that these 3 forces add together to produce no resultant force then the block must either be at rest or moving with a constant velocity (from Newton's 1st law).

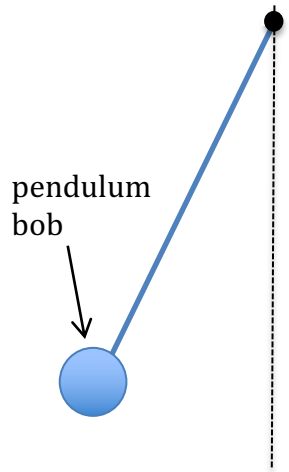
Here is a free body diagram of a an aeroplane:



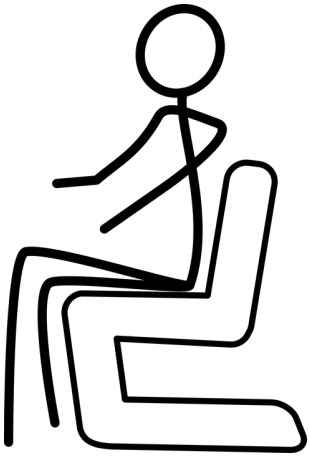
Note the specialist names for forces – 'lift' is the upward force from an aeroplane wing, 'drag' is the resistive force on an object moving through a fluid (in this case air).

(1) Looking at the size of the force arrows, describe the motion of the aeroplane.

(2)✎ Draw a free body diagram of the pendulum bob, below.



(3)✎ Draw a free body diagram of the i) person, ii) the chair. Assume the stick person weighs something!



F=ma

(4)✎ How would you investigate the effect of force on acceleration? Briefly outline an experiment you could carry out. Your description you should include the equipment you would use, the measurements you would take and how you would process your measurements to confirm the relationship F=ma.