14.5: Free-Body Diagrams

Trying to draw every single force acting on every single object can very quickly become pretty messy. And anyway, this is not usually what we need: what we need is to separate cleanly all the forces acting on any given object, one object at a time, so we can apply Newton's second law, $F_{net} = ma$, to each object individually.

In order to accomplish this, we use what are known as *free-body diagrams*. In a free-body diagram, a potentially very complicated object is replaced symbolically by a dot or a small circle, and all the forces acting on the object are drawn (approximately to scale and properly labeled) as acting on the dot. Regardless of whether a force is a pulling or pushing force, the convention is to always draw it *as a vector that originates at the dot*. If the system is accelerating, it is also a good idea to indicate the acceleration's direction also somewhere on the diagram.

The figure below shows, as an example, a free-body diagram for a block, in the presence of both a nonzero acceleration and a friction force. The diagram includes all the forces, even gravity and the normal force.

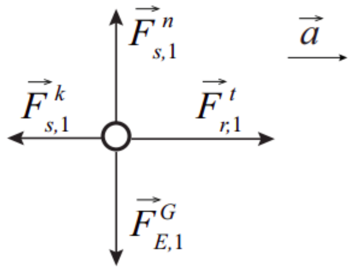

Figure 14.5.1, with the friction force adjusted so as to be compatible with a nonzero acceleration to the right.

Note that I have drawn F^n and the force of gravity $F^G_{E,1}$ as having the same magnitude, since there is no vertical acceleration for that block. If I know the value of the friction force, I should also try to draw F^k approximately to scale with the other two forces. Then, since I know that there is an acceleration to the right, I need to draw F^t greater than F^k, since the net force on the block must be to the right as well.