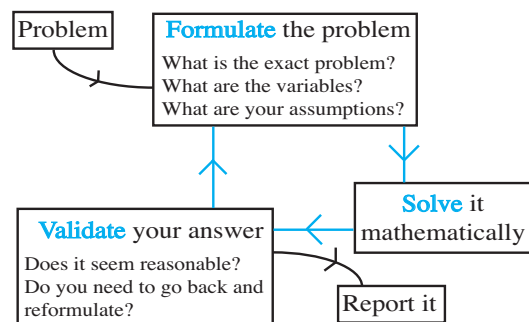


Simplifying mechanics modelling

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The aim of mechanics is to make predictions about real-life situations, but in modelling real-life mechanics problems many difficulties may occur. It is necessary (in many cases) to make life a bit simpler than it really is. In doing this we have to be careful that we do not lose too much information about the problem that we are dealing with. Each time you are given a problem it is best to use an established modelling cycle.



Useful assumptions in mechanics - terminology

There are many common **assumptions** that are made in mechanics to make problems more manageable. In mechanics there are some factors such as air resistance and lift on a golf ball which make a problem difficult to solve. These are often ignored initially and only considered at a later stage if the model needs refining. There are also many other assumptions that are commonly used. Some of these assumptions have specific names. There follows a list and definition of some of these names that may be helpful.

Light When modelling a situation which has strings or rods that connect two objects it is often much easier to make useful predictions if the strings and rods are considered to have no mass. In this case, they are said to be **light**.

Smooth Quite often it is useful to model surfaces and/or objects as frictionless. The term for these types of surfaces and objects is **smooth**. Pulleys are often modelled as smooth in mechanics. This means that there is no friction on the pulley.

Inextensible From experience we know that if we pull a string very hard we can get it to stretch a little bit, but not much. When modelling objects like strings and ropes, it is often useful to assume that we cannot stretch them at all, that is to say that the string (or rope) is **inextensible**. (Note that the term **inelastic** is also used.)

Uniform Most objects in real life have varying properties. However, in certain cases a property may vary very little within the bounds of the problem being studied. For example, air temperature can be very different depending on the location. However, if our model was within a single room it may be reasonable to assume that air temperature is the same everywhere, i.e. air temperature is **uniform**. We could also talk about many other properties being uniform, for example if a body moves with a constant speed in a constant direction, we say it has uniform velocity.

Particle If we model something as a **particle** (see Introduction to Mechanics, 1.1), any force acting on the particle is regarded as being applied at one point. This means that we ignore rotational motion.

Rigid body If we model something as a **rigid body** (see Introduction to Mechanics, 1.1), we ignore bending and stretching forces. However, in contrast to a particle, the point of application of a force acting on a rigid body is not fixed and hence we can have rotations of the rigid-body.

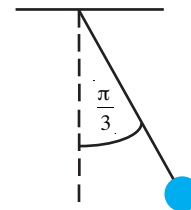
Lamina An object that is very thin can be modelled as a **lamina**. A lamina is a two-dimensional object. A piece of paper is an example of an object that can be treated as a lamina.

Example

A mass is hung by a rope from the ceiling. The mass is lifted with the rope taut so that the rope forms an angle of $\frac{\pi}{3}$ radians with the vertical and then the mass is released. What assumptions might it be useful to make about: a) the rope? b) the weight? c) the environment?

In this simple model, it is a good idea to assume:

a) the rope is light and inextensible. This is because the mass is likely to be much heavier than the rope. If we assume that the rope is inextensible the problem becomes much easier as the motion of the mass will be on a circular path.



b) the mass can be treated as a particle. This immediately means that we are ignoring any rotations of the mass.

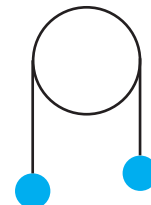
c) there is no air resistance, that is to say we assume that the other forces acting on the mass, e.g. gravity, are much greater than forces due to air resistance.

Three assumptions have been made even in this simple case. However the model remains good because we have chosen to simplify the aspects of the problem that have little effect on the behaviour of the system.

Exercises

1. What assumptions could you make about an ice hockey puck sliding along an ice rink?

2. A mass is attached to each end of a string, which is placed over a pulley (see diagram on the right). What assumptions can be made about the components of the system?



Solutions

1. It would be safe to assume that the puck experiences no friction on the ice, i.e. we could treat the ice as *smooth* in this case. Also, normally we would model the puck as a *particle*.
2. The pulley is said to be *smooth* and the string is said to be *light* and *inextensible*. Finally, each mass is treated as a *particle*.