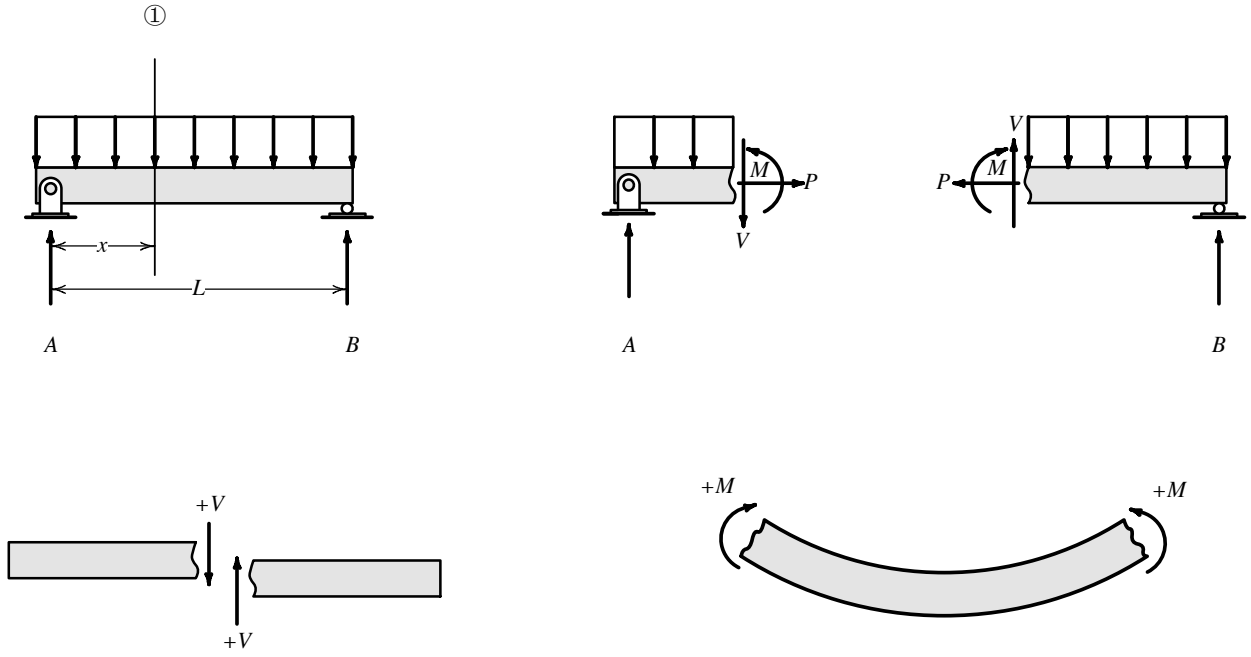
Internal Forces

Internal forces are distributed forces which act inside an object to hold the parts of the object together. Internal forces always act in action-reaction pairs (i.e., left acts on the right, the right acts on the left) that always cancel each other out, so they never appear on a FBD. However, internal forces become exposed when we take an (imaginary) cut though the object or separate the parts.

The internal forces can always be replaced with an equivalent concentrated force and a concentrated moment acting on the cut surface. Further, the concentrated force can be resolved into components parallel and perpendicular to the cut surface known as the *shear force* and the *normal force*. The concentrated moment is called the *bending moment*. For beams supporting only vertical forces, the normal force is zero

When working with internal forces we use the following sign convention:

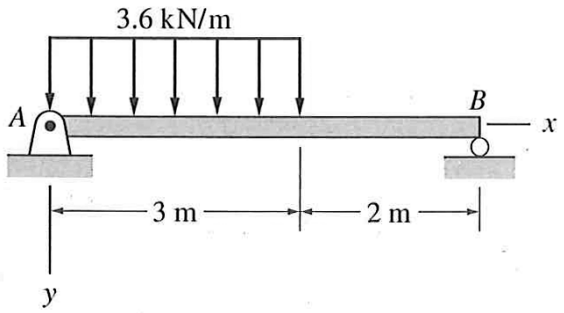


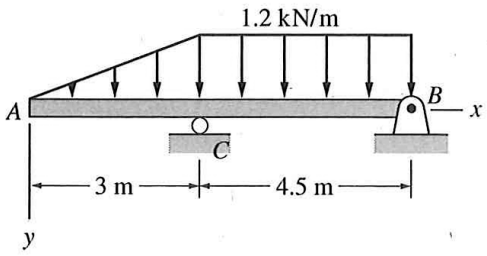
To find the internal forces at a given point:

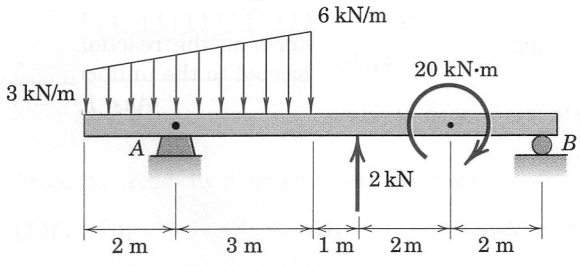
1. Find reactions if necessary.
2. Take an imaginary cut through the point of interest.
3. Draw a free body diagram of one half of the object, exposing an internal shear, normal force and bending moment. Draw the arrows according to the sign convention for shear and bending moments.
4. Solve for the three unknown internal forces using the standard approach. Negative shears and moments indicate that assumed directions are incorrect and actual values are opposite the assumed direction.

Problems 1, 2, and 3:

Find the shear and bending moment at the midpoint of each of the beams.







Problem 4

A pin connected circular arch supports a 5000 lb load as shown. Neglecting the weights of the members determine the normal force, shear force, and bending moment that act on the cross section at ①.

Comment on how the result would change if member *BC* was straight. Which is the better design?