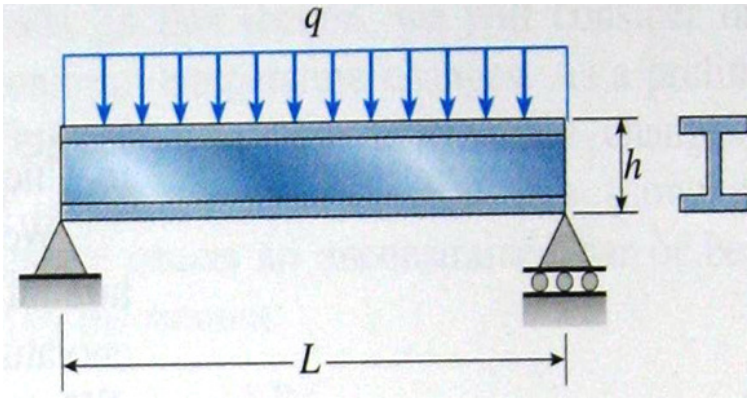
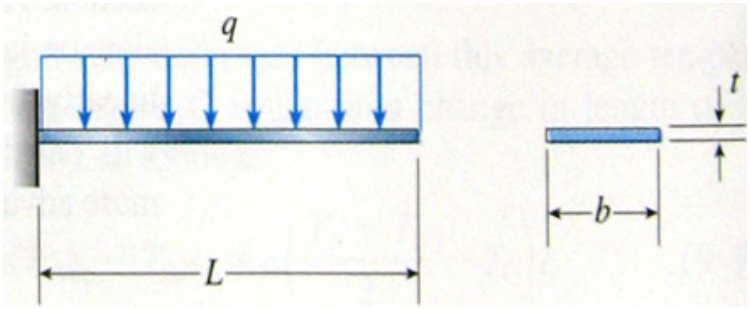
EGBE260
W15 Homework: Deflection of Beams

9.3-4. A uniformly loaded steel wide-flange beam with simple supports has a downward deflection of 12 mm at the midpoint and angles of rotation equal to 0.01 radians at the ends. Calculate the height h of the beam if the maximum bending stress is 75 MPa and the modulus of elasticity is 200 GPa.



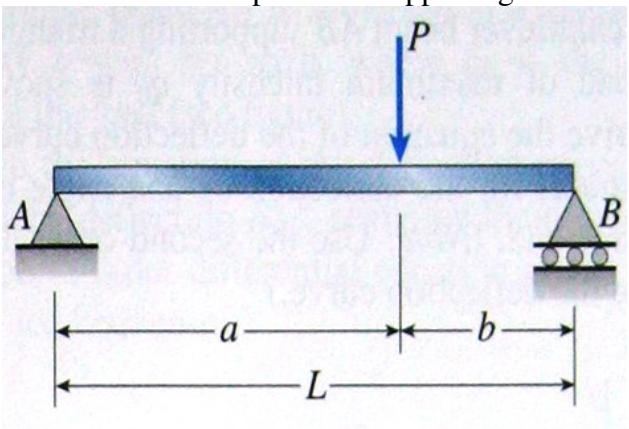
Answer: h = 96 mm

9.3-6. A gold-alloy microbeam attached to a silicon wafer behaves like a cantilever beam subjected to a uniform load. The beam has length L = 25 μm, and thickness t = 0.87 μm. The total load on the beam is 44 μN. If the deflection at the end of the beam is 1.3 μm, what is the modulus of elasticity E of the gold alloy?



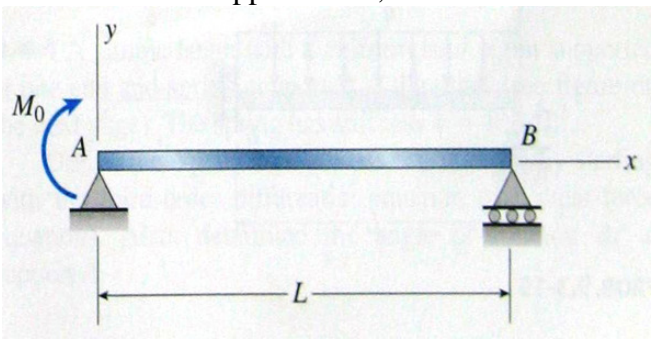
Answer: E = 80.3 GPa

9.3.10. Obtain a formula for the ratio δ_C/δ_{max} of the deflection at the midpoint to the maximum deflection for a simple beam supporting a concentrated load P.



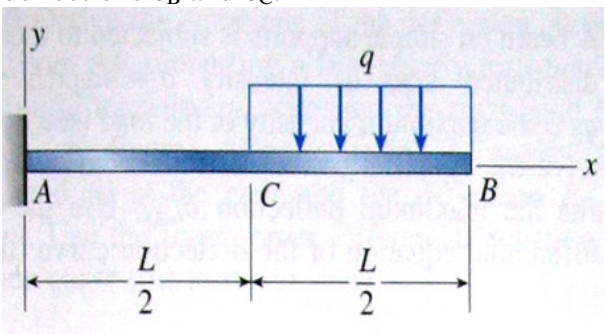
Answer check: If a/L / ¾, δ_C/δ_{max} =0.9839

9.3-12. Derive an equation of the deflection curve for a simple beam AB loaded by a couple M_0 at the left-hand support. Also, determine the maximum deflection δ_{max}.



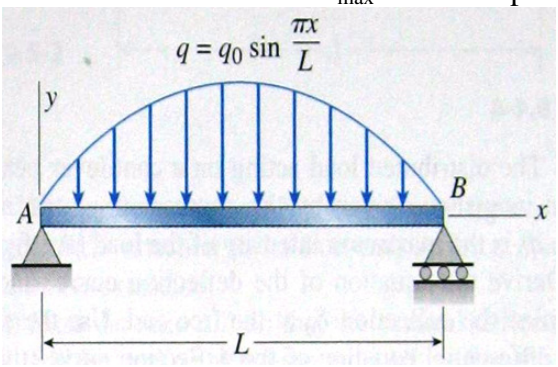
Check the table for the answer

9.3-18. Derive the equations of the deflection curve for a cantilever beam AB supporting a uniform load of intensity q acting over one-half of the length. Also, obtain formulas for the deflections δ_B and δ_C.



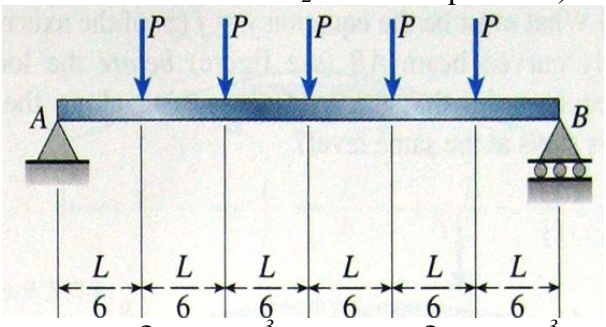
Answer: $v = -qLx^2(9L-4x)/48EI$ for $0<x<L/2$; $v=-q(16x^4-64Lx^3+96L^2x^2-8L^3x+L^4)/384EI$ for $L/2<x<L$; $\delta_B = 41qL^4/384EI$; $\delta_C = 7qL^4/192EI$.

9.4-2. A simple beam AB is subjected to a distributed load of intensity $q = q_0 \sin \pi x/L$, where q_0 is the maximum intensity of the load. Derive the equation of the deflection curve, and then determine the deflection δ_{max} at the midpoint of the beam.



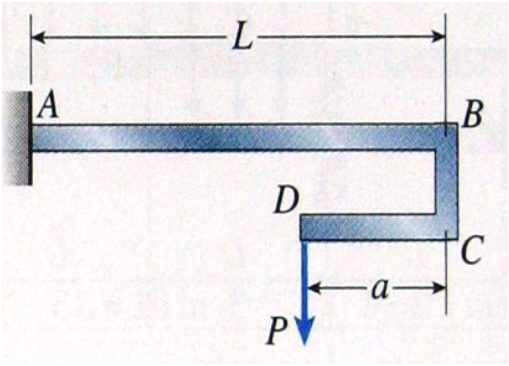
See Table for answer

9.5-2. A simple beam AB supports 5 equally spaced loads P. a) Determine the deflection δ_1 at the midpoint of the beam. If the same total load (5P) is distributed as a uniform load on the beam, what is the deflection δ_2 at the midpoint? C) Calculate the ratio of δ_1 to δ_2.



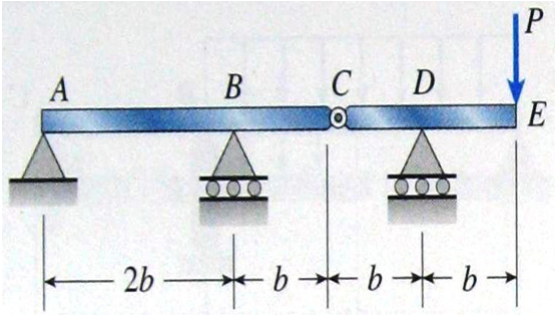
Answers: $\delta_1 = 11PL^3/144EI$; b) $\delta_2 = 25PL^3/34EI$; c) $\delta_1/\delta_2 = 88/75 = 1.173$.

9.5-3. The cantilever beam AB shown in the figure has an extension BCD attached to its free end. A force P acts on the end of the extension. A) Find the ratio a/L so that the vertical deflection of point B will be 0. b) find the ratio a/L so that the angle of rotation at point B will be 0.



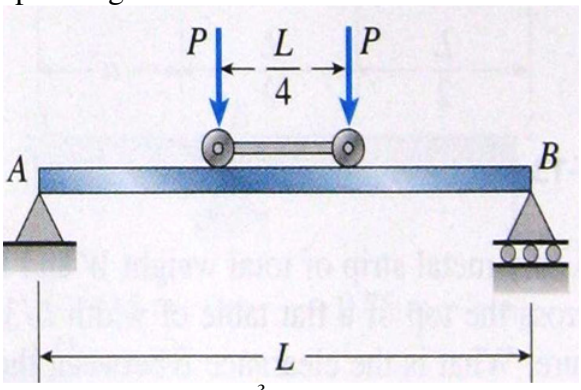
Answers: a) a/L = 2/3; b) a/L = ½.

9.5-18. A compound beam ABCDE consists of two parts (ABC and CDE) connected by a hinge at C. Determine the deflection δ_E at the free end E due to the load P acting at that point.



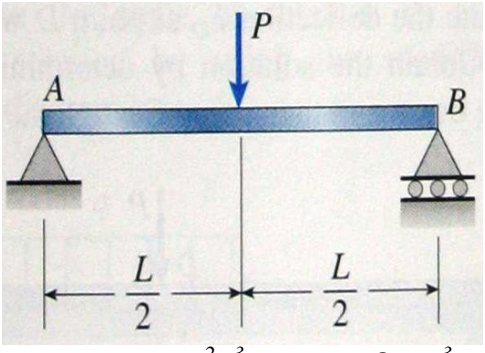
Answer: $\delta_E = 5Pb^3/3EI$

9.5-22. Two equal wheel loads P, distance L/4 apart, move slowly across a simple beam AB of span length L. Determine the maximum value of the deflection δ_C at the midpoint of the beam.



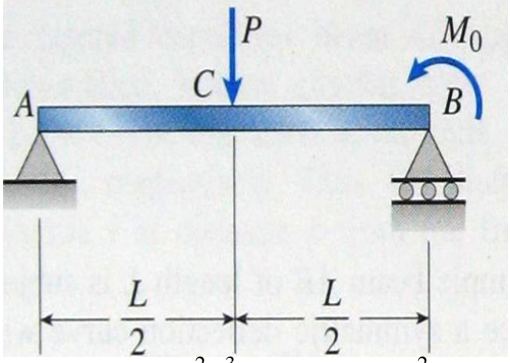
Answer: $\delta_C = 39PL^3/1024EI$

9.8-1. A simple beam AB of length L supports a concentrated load P at the midpoint. A) Evaluate the strain energy of the beam from the bending moment in the beam. B) Evaluate the strain energy of the beam from the equation of the deflection curve. C) From the strain energy, determine the deflection δ under the load P.



A and B) $U = P^2L^3/96EI$; *c)* $\delta = PL^3/48EI$

9.8-6. A simple beam ACB supporting a concentrated load P at the midpoint and a couple of moment M_0 at one end is shown below. Determine the strain energy U stored in the beam due to the force P and the couple M_0 acting simultaneously.



Answer: $U = P^2L^3/96EI + PM_0L^2/16EI + M_0^2L/6EI$