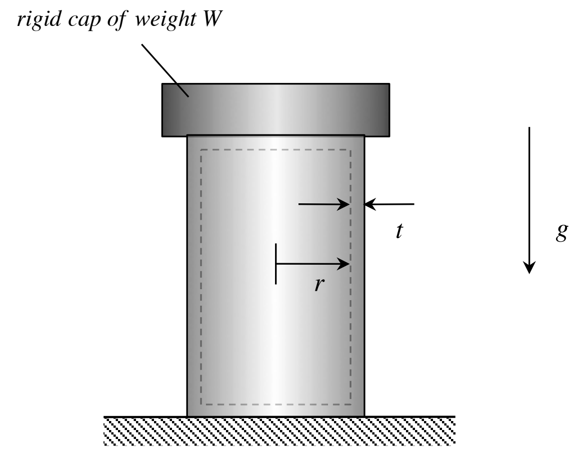
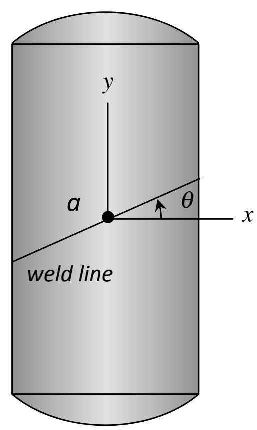
Conceptual question 12.1



A thin-walled tank (having an inner radius of r and wall thickness t) constructed of a ductile material contains a gas with a pressure of p. A rigid cap of weight $W = 3\pi p r^2$ rests on top of the tank. Ignore the weight of the tank. Determine the principal components of stress in the wall of the tank.

Conceptual question 12.2



A weld is used to join two sections of a closed, thin-walled tank, with the weld line being at an angle of θ with respect to the x-axis, as shown above. Circle the weld line angle θ below that produces the largest *in-plane shear stress* along the weld:

i) $\theta = 0$

ii) $\theta = 22.6°$

iii) $\theta = 30°$

iv) $\theta = 45°$

v) $\theta = 60°$

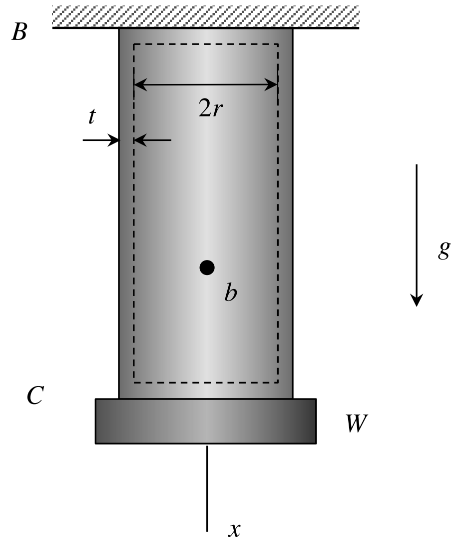
vi) $\theta = 67.4°$

vii) $\theta = 90°$

viii) none of the above

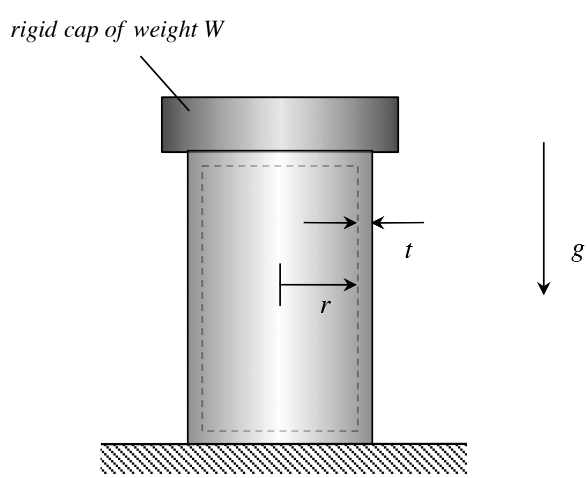
ix) more information about the problem is needed in order to answer this question

Conceptual question 12.3



Consider the thin-walled pressure vessel above that contains a gas under a pressure of p. The vessel is attached to a fixed support at B and has a plate of weight W attached to it at end C. Ignore the weight of the vessel. Determine the weight W of the plate for which the *maximum in-plane shear stress* in the vessel at point "b" is *zero*.

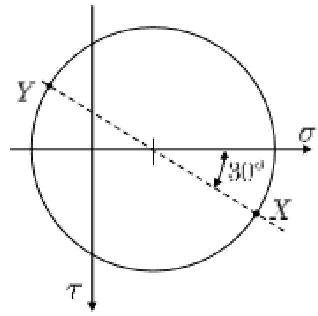
Conceptual question 12.4



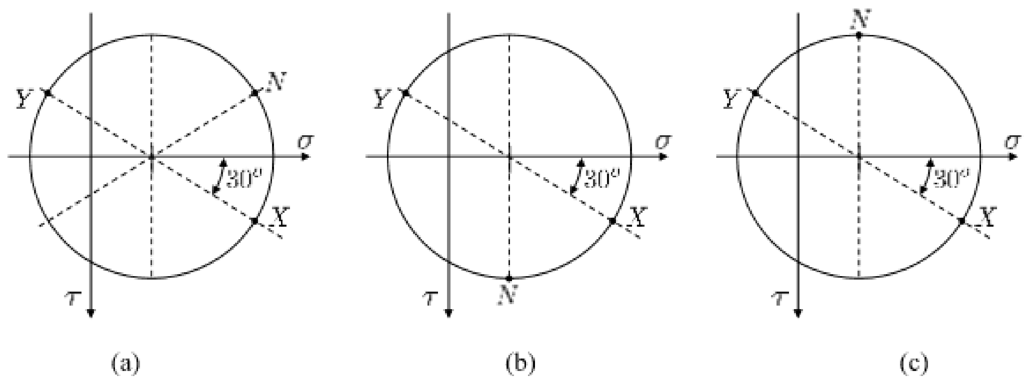
A thin-walled tank (having an inner radius of r and wall thickness t) contains a gas with a pressure of p. A rigid cap of weight $W = 2\pi p r^2$ rests on top of the tank. Ignore the weight of the tank. Determine the maximum in-plane shear stress in the tank wall.

Conceptual question 13.1

Consider the plane state of stress represented in the figure shown below.

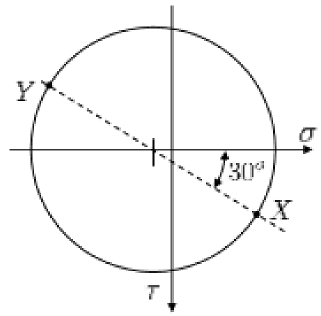


Circle the figure that represents the stress at a plane with normal $\underline{\boldsymbol{n}}$ that is oriented 60° from x-axis and is labeled as N in the figures.



Conceptual question 13.2

PART B - 3 points: The Mohr's circle shown in the figure corresponds to a three-dimensional state of stress with one principal stress equal to zero.



Circle the correct answer in the following two statements:

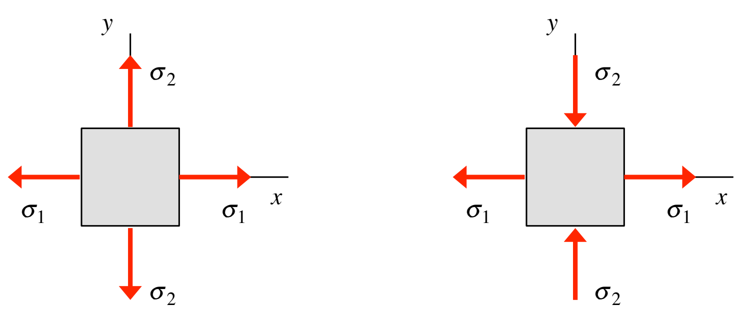
1) The normal stress acting on the planes of absolute maximum shear stress is a:

(a) Compressive stress. (b) Tensile stress.

2) The three principal stresses ($\sigma_1 \geq \sigma_2 \geq \sigma_3$) act on planes with normal p_1, p_2, p_3 (also referred to as principal directions). For the p_1p_2 plane stress transformation, the normal stress acting on the planes of maximum shear stress is a:

(a) Compressive stress. (b) Tensile stress.

Conceptual question 13.3



stress state (a) *stress state (b)*

Consider stress states (a) and (b) shown above, with $|\sigma_1| > |\sigma_2|$. Let $\left(|\tau|_{max,abs}\right)_a$ and $\left(|\tau|_{max,abs}\right)_b$ represent the absolute maximum shear stress corresponding to stress states (a) and (b), respectively. Circle the response below that describes the relative sizes of these stresses:

i) $\left(|\tau|_{max,abs}\right)_a > \left(|\tau|_{max,abs}\right)_b$

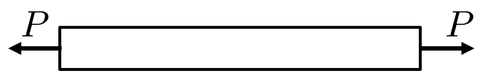
ii) $\left(|\tau|_{max,abs}\right)_a = \left(|\tau|_{max,abs}\right)_b$

iii) $\left(|\tau|_{max,abs}\right)_a < \left(|\tau|_{max,abs}\right)_b$

iv) more information about the stress states is needed in order to answer this question

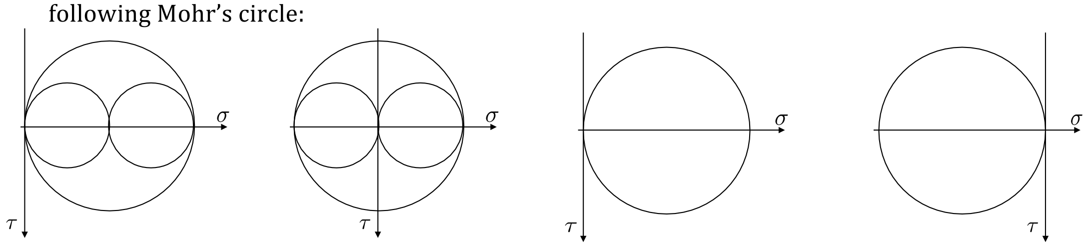
Conceptual question 13.4

A steel cylindrical specimen is subjected to tension until ductile failure is observed.



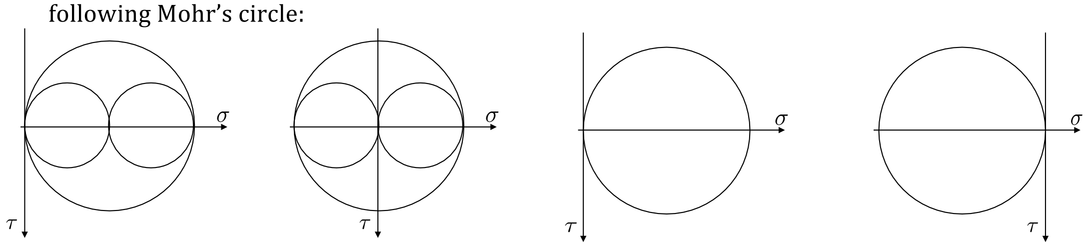
Circle the correct answer in the following statements:

(a) The state of stress of a point on the *top fiber* of the specimen is represented by the following Mohr's circle:



(i) (ii) (iii) (iv)

(b) The state of stress of a point on the *bottom fiber* of the specimen is represented by the following Mohr's circle:

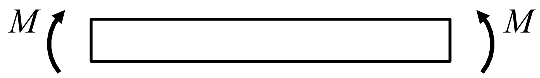


(i) (ii) (iii) (iv)

(c) Before (i) / After (ii) necking occurs, a crack oriented at 0° (iii) / 45° (iv) / 90° (v) from the direction of loading will develop.

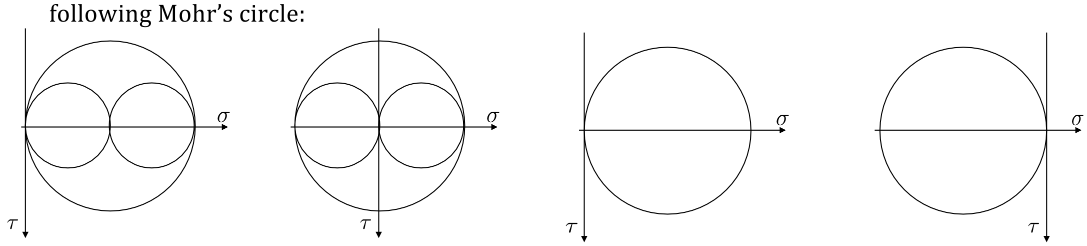
Conceptual question 13.5

A concrete slab is subjected to bending until brittle failure is observed. As in most brittle materials, the ultimate compressive strength is larger than the ultimate tensile strength.



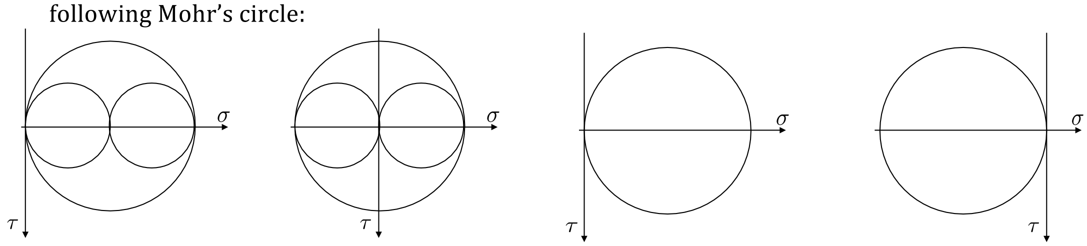
Circle the correct answer in the following statements:

(a) The state of stress of a point on the *top face* of the specimen is represented by the following Mohr's circle:



(i) (ii) (iii) (iv)

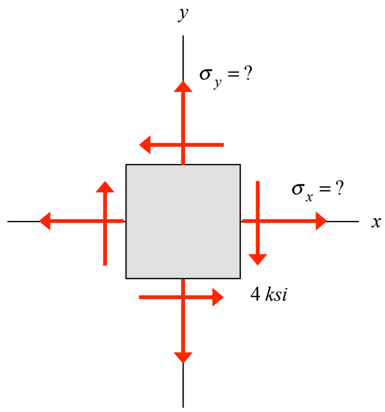
(b) The state of stress of a point on the *bottom face* of the specimen is represented by the following Mohr's circle:

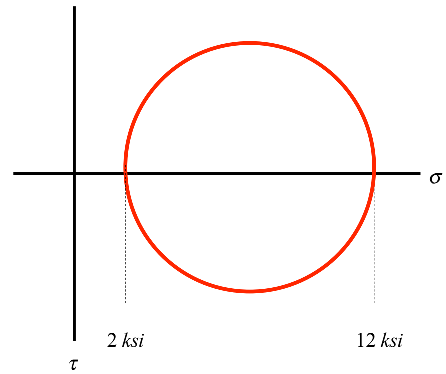


(i) (ii) (iii) (iv)

(c) The first cracks develop on the top face (i) / bottom face (ii) and are oriented vertically (iii) / obliquely (iv) / horizontally (v).

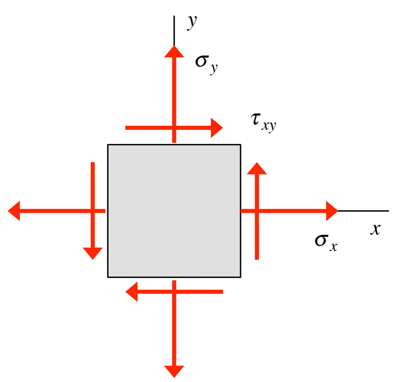
Conceptual question 13.6

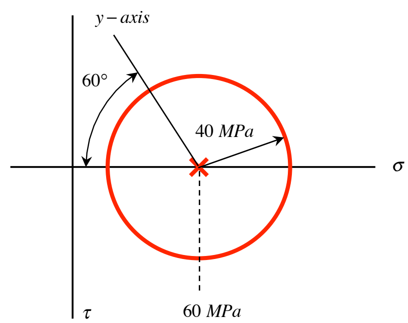




Consider the state of plane stress shown above left where the two normal components of stress, σ_x and σ_y, are unknown. The Mohr's circle for this state of stress is provided in the figure above right. Determine numerical values for the two normal components of stress σ_x and σ_y. There may be more than one set of answers; you need only find one set.

Conceptual question 13.7





The Mohr's circle for a stress state is presented above.

a) Determine the values of σ_x, σ_y and τ_{xy} for this stress state.

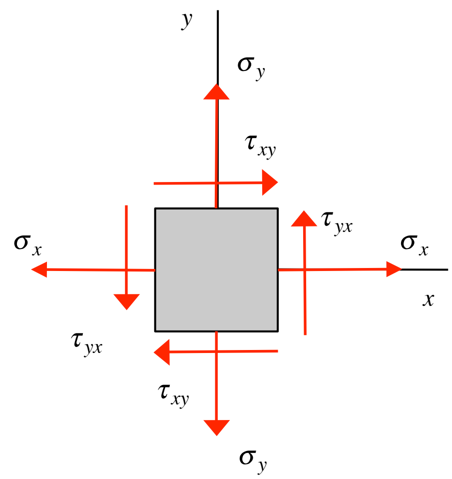
b) What is the maximum absolute shear stress for the stress state?

c) What is the smallest counter-clockwise rotation of the stress element above that will show the principal stresses on its faces?

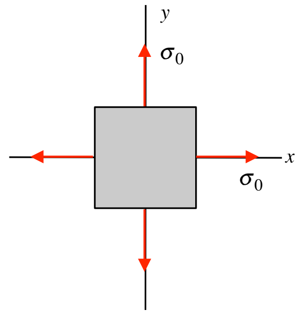
Conceptual question 13.8

For the state of plane stress shown below, it is known that $\tau_{xy} = \tau_{yx}$ when:

a) the stress state is in the linear elastic range.
b) the stress state corresponds to yielding or below.
c) the stress state corresponds to necking or below.
d) the stress state corresponds to rupture or below.
e) always (all of the above).
f) never: $\tau_{xy} = \tau_{yx}$ at <u>no</u> states of stress.



Conceptual question 13.9



The stress element for a particular state of stress is shown above. Let $|\tau|_{max,in-plane}$ and $|\tau|_{max,abs}$ represent the maximum in-plane shear stress and the absolute maximum shear stress, respectively, that corresponds to this state of stress. Circle the answer below that most accurately represents the relative sizes of $|\tau|_{max,in-plane}$ and $|\tau|_{max,abs}$:

a) $0 < |\tau|_{max,in-plane} < |\tau|_{max,abs}$

b) $0 = |\tau|_{max,in-plane} < |\tau|_{max,abs}$

c) $0 < |\tau|_{max,abs} < |\tau|_{max,in-plane}$

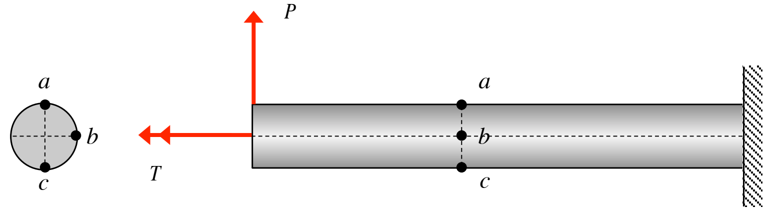
d) $0 = |\tau|_{max,abs} < |\tau|_{max,in-plane}$

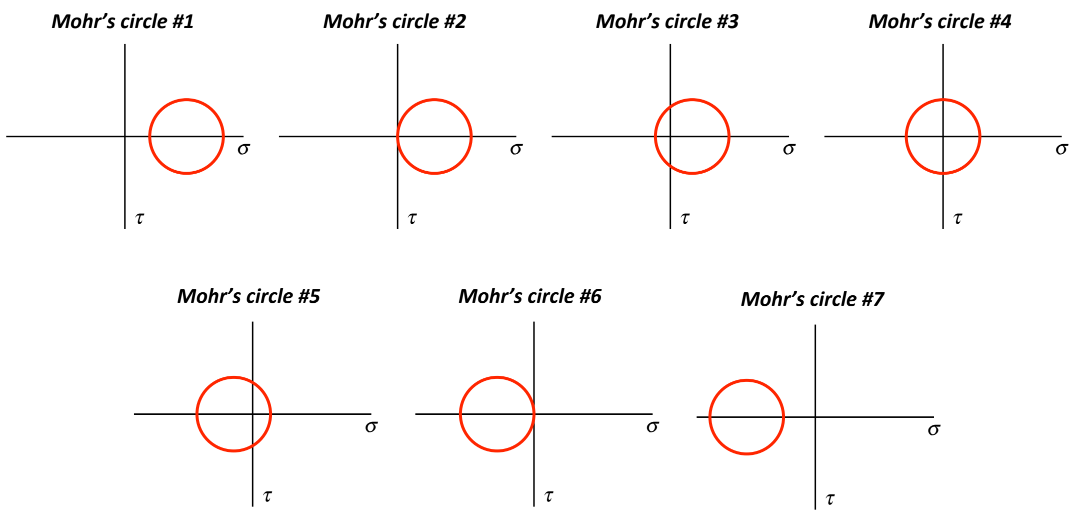
e) $0 < |\tau|_{max,in-plane} = |\tau|_{max,abs}$

f) $0 = |\tau|_{max,in-plane} = |\tau|_{max,abs}$

g) More information is needed about the state of stress in order to answer this question.

Conceptual question 14.1

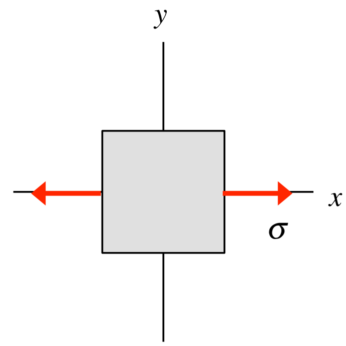




A cantilevered beam is loaded with a transverse force P and an axial torque T at its left end. Consider points "a", "b" and "c" on a cross section of the beam. In this problem, you are asked to match the stress state at each point with a Mohr's circle (Mohr's circles #1-#7). For this, circle the Mohr's circle below that matches each cross section point:

- *Point "a":* Mohr's circle ***#1 #2 #3 #4 #5 #6 #7***
- *Point "b":* Mohr's circle ***#1 #2 #3 #4 #5 #6 #7***
- *Point "c":* Mohr's circle ***#1 #2 #3 #4 #5 #6 #7***

Conceptual question 15.1



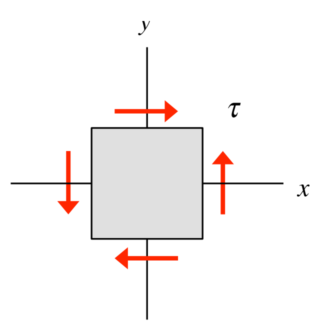
Consider the state of stress shown above in a *ductile* material. Let σ_{MSS} and σ_{MDE} be the values of the normal stress σ above that correspond to failure of the material using the maximum shear stress and maximum distortional energy theories, respectively. Circle the answer below the best describes the relative sizes of σ_{MSS} and σ_{MDE}. Provide a written explanation for your answer.

a) $\sigma_{MSS} < \sigma_{MDE}$

b) $\sigma_{MSS} = \sigma_{MDE}$

c) $\sigma_{MSS} > \sigma_{MDE}$

Conceptual question 15.2



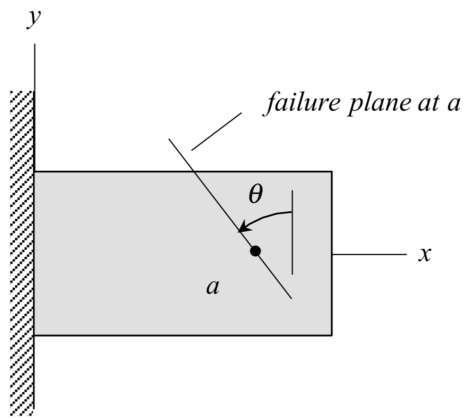
Consider the state of stress shown above in a *ductile* material. Let τ_{MSS} and τ_{MDE} be the values of the shear stress τ above that correspond to failure of the material using the maximum shear stress and maximum distortional energy theories, respectively. Circle the answer below the best describes the relative sizes of τ_{MSS} and τ_{MDE}. Provide a written explanation for your answer.

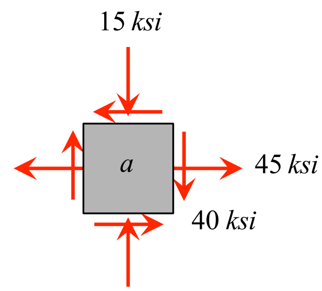
a) $\tau_{MSS} < \tau_{MDE}$

b) $\tau_{MSS} = \tau_{MDE}$

c) $\tau_{MSS} > \tau_{MDE}$

Conceptual question 15.3





Loading (not shown) acting on the structural member above produces the x-y components of the state of stress for point "a" shown above. This state of stress is known to have produced failure in the ductile material of the structural member at point "a". What is the angle θ that defines the failure plane at point "a"?

Conceptual question 18.3

PART D - 5 points: Given the following five configurations of an ideal column under vertical force, rank the critical buckling loads from smallest to largest and circle the correct answer:

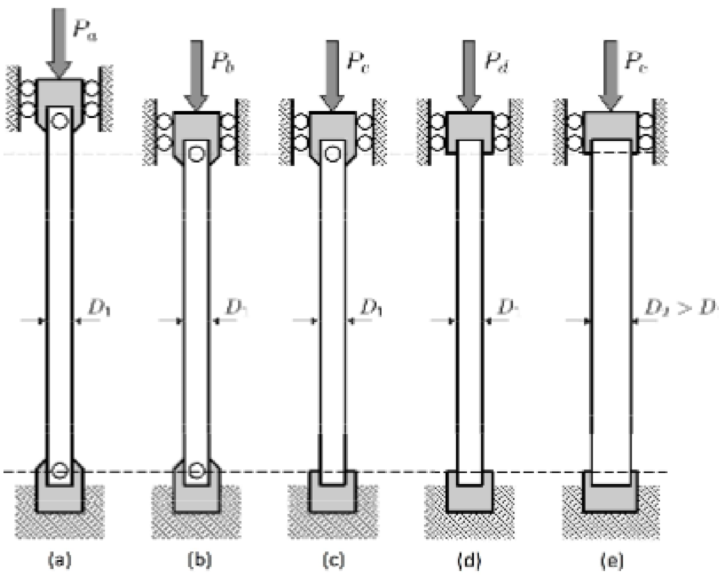
(i) $P_e < P_d < P_c < P_b < P_a$

(ii) $P_a < P_b < P_e < P_d < P_c$

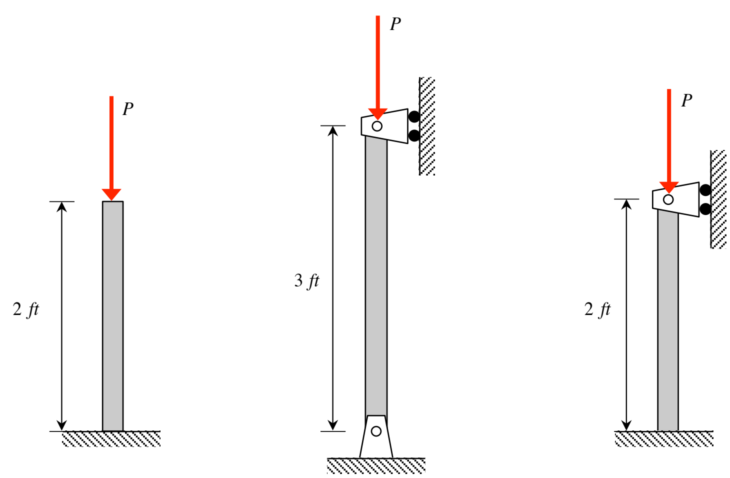
(iii) $P_a < P_b < P_c < P_d < P_e$

(iv) $P_d < P_e < P_c < P_b < P_a$

(v) $P_b < P_a < P_d < P_c < P_e$



Conceptual question 18.4



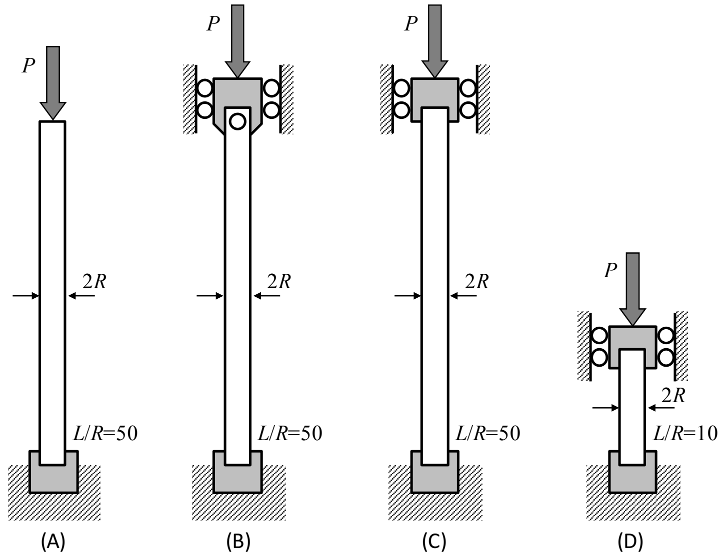
column A ***column B*** ***column C***

Columns A, B and C shown above are made of the same material (Young's modulus of E) and have the same circular cross-section. The same compressive axial load P is applied to each column.

a) Determine the critical load for in-plane buckling for each column.

b) For which column is the critical load the least?

Conceptual question 18.5



Cylindrical columns A, B, C and D shown above are made of the same material (Young's modulus of E and yield stress of $\sigma_Y = E/100$) and have the same circular cross-section of radius R. A compressive axial load P is applied to each column.

The critical buckling loads P_{cr}^A, P_{cr}^B, P_{cr}^C, and P_{cr}^D for columns A, B, C, and D, respectively, are such that:

(i) $\pi R^2 \sigma_Y/2 > P_{cr}^D > P_{cr}^C > P_{cr}^B > P_{cr}^A$

(ii) $P_{cr}^D > P_{cr}^A > P_{cr}^C > P_{cr}^B$

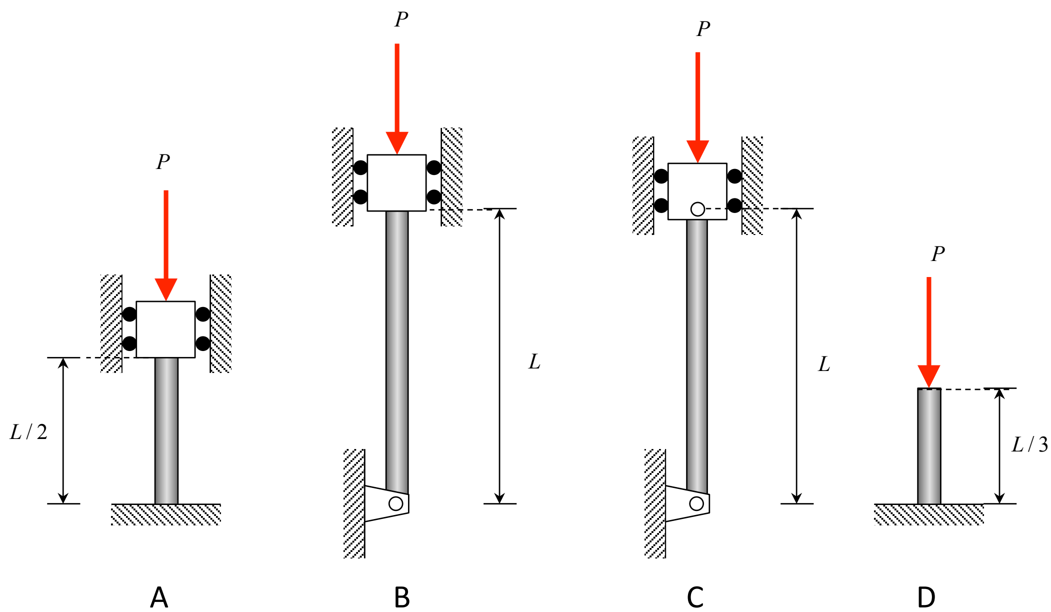
(iii) $\pi R^2 \sigma_Y > P_{cr}^D > \pi R^2 \sigma_Y/2 > P_{cr}^C > P_{cr}^B > P_{cr}^A$

(iv) $P_{cr}^D > P_{cr}^B > P_{cr}^C > P_{cr}^A$

(v) $P_{cr}^D > P_{cr}^C > P_{cr}^B > P_{cr}^A$

(vi) None of the above.

Conceptual question 18.6



Consider the four columns (A, B, C and D) shown above with differing boundary conditions and lengths. The loading is the same for each column, each column is made up of the same material having a Young's modulus and each column has the same circular cross section.

a) Which column has the ***largest*** critical Euler buckling load? A B C D

b) Which column has the ***second largest*** critical Euler buckling load? A B C D

c) Which column has the ***smallest*** critical Euler buckling load? A B C D

Conceptual question 18.7

Consider a column that is loaded with a compressive axial load *P*. The material of the column has a yield strength of $\sigma_Y = 60\ ksi$. The applied load produces an axial stress having a magnitude of $|\sigma_x| = 40\ ksi$. It is desired to determine the largest length of the column for which the column will not buckle under this load of *P*. Should you use the *Euler theory* or the *Johnson theory* in your buckling analysis? Explain.

Conceptual question 18.8

Consider the column shown below with a length $L = 100\ in$ that is loaded with a compressive axial load *P*. The material of the column has a Young's modulus $E = 30 \times 10^3\ ksi$ and a yield strength of $\sigma_Y = 40\ ksi$. The column cross section has a second area moment of $I = 10\ in^4$ and an area of $A = 10\ in^2$. It is desired to determine the in-plane critical buckling load P_{cr}. Should you use the *Euler theory* or the *Johnson theory* in your buckling analysis? Explain.