*. (10 points) A copper ball ($\alpha = 17 \times 10^{-6}/\text{K}$) of radius 13.010 cm is placed in a 13.000 cm radius circular hole of an aluminum plate ($\alpha = 23 \times 10^{-6}/\text{K}$). Both the ball and plate are at 20°C.

a. (4 points) To what temperature must the copper ball and aluminum plate both be raised or lowered to in order for the ball to be able to pass through the plate?

$\Delta R_{Cu} = \alpha_{Cu} R_{Cu} \Delta T \Rightarrow R_{Cu,f} = (1 + \alpha_{Cu} \Delta T) R_{Cu,i}$ ← equal

$\Delta R_{Al} = \alpha_{Al} R_{Al} \Delta T \Rightarrow R_{Al,f} = (1 + \alpha_{Al} \Delta T) R_{Al,i}$

$(1 + \alpha_{Cu} \Delta T) R_{Cu,i} = (1 + \alpha_{Al} \Delta T) R_{Al,i}$

$R_{Cu,i} - R_{Al,i} = (\alpha_{Al} R_{Al,i} - \alpha_{Cu} R_{Cu,i}) \Delta T$

$\Delta T = \dfrac{13.010 - 13.000}{(23)(13.000) - (17)(13.010)} \dfrac{\text{cm}}{\text{cm } 10^{-6}/\text{K}} = +128.49\,\text{C}^\circ \Rightarrow$ $T_f = 150\,^\circ\text{C}$

b. (4 points) Same problem, except consider a 13.010 cm *aluminum* ball on top of a 13.000 cm circular hole in a *copper* plate.

$\Delta T = \dfrac{13.000 - 13.010}{(23)(13.010) - (17)(13.000)} \dfrac{\text{cm}}{\text{cm } 10^{-6}/\text{K}} = -127.83\,\text{C}^\circ \Rightarrow$ $T_f = -110\,^\circ\text{C}$

c. (2 points) What if the ball and the plate are both made of copper?

No temperature change will make $R_{ball} = R_{hole}$