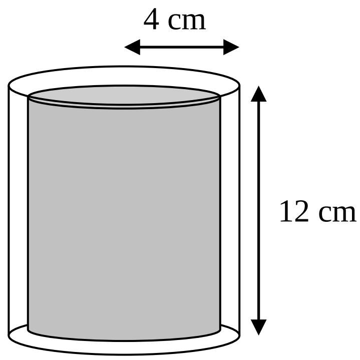
PHYS 2130 Quiz #1 **Name ______________________**



Water is placed in a styrofoam cup with a styrofoam lid. Assume the cup and lid form a cylinder of radius 4.00 cm, height of 12.0 cm, and wall thickness of 0.500 cm. The water's initial temperure is 95 °C and the surroundings are at 20 °C.

a) What is the rate of heat flow through the styrofoam cup? (The thermal conductivity of styrofoam is 0.029 W/m·K.) (6 pts)

Find the surface area of the cup. The wall will be circumference time height and the lid and base will be the area of a circle.

$$A = \pi r^2 + \pi r^2 + 2\pi r h = 2\pi r^2 + 2\pi r h = 2\pi r(r+h)$$

$$A = 2\pi(0.040m)(0.040m + 0.120m) = 0.0402m^2$$

Now calculate the heat flow through the cup

$$H = -k_t A \frac{\Delta T}{\Delta x}$$

$$H = -(0.029W/mK)(0.0402m^2)\frac{(20^o C - 95^o C)}{(0.0050m)} = 17.5W$$

b) Assuming the rate of heat flow calculated above is constant, how long does it take the temperature of the water to drop to 90 °C? (The mass of water that fits in this cup is 603 g.) (3 pts)

Rate of heat flow is the change of heat over the change in time. Therefore,

$$H = \frac{\Delta Q}{\Delta t} = \frac{mc\Delta T}{\Delta t}$$

Solving for the change of time gives

$$\Delta t = \frac{mc\Delta T}{H} = \frac{(603g)(4.184J/g \cdot C)(95-90)}{17.5W} = 720\ s$$

This time is equal to 12 minutes.

c) Due to the assumption of constant heat flow, is the time calculated in part b smaller or larger than the actual time for the water to reach 90 °C? (1 pt)

As the coffee cools the rate of heat flow will go down. Therefore, the time in part b is ***smaller*** *than the actual time.*