1. Which of the following is NOT one of the five steps to deriving a differential equation?
   A. Substitute the flux equation (i.e. Fourier’s Law, Newton’s Law of Viscosity, etc.)
   B. Make a sketch
   C. Divide by the independent ∆’s and take the limit as they go to zero
   D. Use the BC’s to evaluate C₁ and C₂

2. What is the shape of a differential element for a three-dimensional heat conduction problem in rectilinear coordinates (3D USS HT)?
   A. An infinite flat sheet ∆x thick
   B. An infinitely long French-fry-shaped element with a cross section ∆y by ∆x
   C. A small cube ∆x by ∆y by ∆z
   D. None of the above

3. What is the shape of a differential element for a heat conduction problem in a cylinder in which the temperature varies in both the radial and axial directions? No generation.
   A. A solid cylinder L long with
   B. A tube L long with a radius r and a wall thickness of ∆r
   C. A ring ∆z long with a radius r and wall thickness of ∆r
   D. A thin disk ∆z thick with a radius r

4. What shape of the differential element for a heat conduction problem involving a sphere in which the temperature varies with r?
   A. A solid sphere with radius ∆r
   B. A solid sphere with radius r
   C. A spherical shell ∆r thick with radius r
   D. A small element ∆θ, dφsinθ, by ∆r at radius r.

5. What is the area through which the radial flux (r-dir) moves in a cylindrical element L long?
   A. πrL
   B. 2πrL
   C. πr²
   D. 2πrΔr
6. What is the area through which an axial flux (z-dir) moves through a cylindrical element \( \Delta z \).
   A. \( \pi r^2 \)
   B. \( 2\pi r \Delta z \)
   C. \( 2\pi r \Delta r \)
   D. \( 2\pi r \Delta L \)

7. What is the volume of a spherical differential in which \( r \) is the only independent position variable?
   A. \( \pi r^3 \)
   B. \( 4\pi r^2 \Delta r \)
   C. \( 2\pi r \Delta z \)
   D. \( (4/3)\pi r^2 \Delta r \)

8. Which is the correct equation for a heat balance for a cylindrical coordinate heat conduction problem in which temperature varies in the radial direction only? No generation.
   A. \( \left[ (2\pi L r q_r)_r - (2\pi L r q_r)_r+\Delta r \right] \Delta t = 2\pi L r \Delta r \rho C P \left( T_{r+\Delta r} - T_r \right) \)
   B. \( 2\pi L \left( (q_r)_r - (q_r)_{r+\Delta r} \right) \Delta t = 2\pi L r \Delta r \rho C P \left( T_{r+\Delta r} - T_r \right) \)
   C. \( 2\pi L \left( (r q_r)_r -(r q_r)_{r+\Delta r} \right) \Delta t = \pi r^2 L \rho C P \left( T_{r+\Delta r} - T_r \right) \)
   D. None of the above

9. Which is the correct equation for a rectilinear coordinate heat conduction problem in which temperature varies in the x and y directions only? No generation. The solid is W wide (x-dir), H high (y-dir), and L long (z-dir).
   A. \( \left[ L \Delta y \left( q_y \mid y - q_y \mid y+\Delta y \right) + L \Delta x \left( q_y \mid y - q_y \mid y+\Delta y \right) \right] \Delta t = L \Delta x \Delta y \rho C P \left( T_{x+\Delta x} - T_x \right) \)
   B. \( W \Delta x \left( q_y \mid y - q_y \mid y+\Delta y \right) + W \Delta y \left( q_y \mid y - q_y \mid y+\Delta y \right) \Delta t = W \Delta x \Delta y \rho C P \left( T_{y+\Delta y} - T_y \right) \)
   C. \( \Delta y \left( q_y \mid y - q_y \mid y+\Delta y \right) + \Delta x \left( q_y \mid y - q_y \mid y+\Delta y \right) \Delta t = \Delta x \Delta y \rho C P \left( T_{y+\Delta y} - T_y \right) \)
   D. None of the above

10. What is the definition of the derivative \( \frac{dy}{dx} \)?
    A. \( \text{Lim as } x \to 0 \frac{y \mid_{x+\Delta x} - y \mid_x}{\Delta x} \)
    B. \( \text{Lim as } x \to 0 \frac{y \mid_x - y \mid_{x+\Delta x}}{\Delta x} \)
    C. \( \text{Lim as } x \to 0 \frac{y \mid_{x+\Delta x} - y \mid_x}{\Delta y} \)
    D. None of the above
Correct Answers: 1-D  2-C  3-C  4-C  5-B  6-C  7-B  8-A  9-A  10-D

Adjustments:  
#6 could be A since it was not specified that there was any change in the r direction  
#8 20% credit will be given for B if you promise to never make that mistake again  
#10 50% credit will be given for A since it is correct except for no delta in the limit