2-1C. Heat transfer is a vector quantity because transfer has direction as well as magnitude.

Temperature is a scalar quantity because temperature just has magnitude but no direction.

2-2C. Steady heat transfer means no change with time within the medium, while transient heat transfer means variation with time.

2-3C. This model is \( \text{2d, transient, cylindrical model} \).

The origin should be the origin of bottom circle surface.

Because the geometry is cylinder, we choose \( 2\text{d - cylindrical model} \).

And the temperature of drink will change with time. So we use transient model \( \text{1d} \).

2-4C. We should use \( \text{1d, transient, spherical model} \).

We choose \( \text{1d, spherical because of its geometry is similar with sphere} \). Also, temperature will change with time, therefore, we choose \( \text{transient model} \). The origin should be in the central point of potato in order to simplify differential equ
- 5C. We should use 1d, transient, spherical model, and the origin should be in the central point of egg.

The reason is the same as 2-4C.

2-6C. We should use 1d, transient, cylindrical model.

The origin should be in the central point of hot dog.

We choose 3d because we assume the length is infinite.

The reason is the same as 23C.

-7C. This is a transient heat transfer problem.

We can consider it as 2-dimensional problem.

The bottom section of the roast beef has a large surface area relative to its thickness, and can be approximated as a large plane wall. So we can consider it as 2-d.

Temperature change with time $\Rightarrow$ transient.
2-8 C. This is a 2-d. transient problem. Cylindrical coordinate should be used in this situation. The explanation is the same as 2-3 C

2-9 C. Yes, because temperature's gradient is vertical to isothermal surface and heat flux vector is opposite direction to temperature's gradient. \( \Rightarrow \) heat flux vector is also perpendicular to the surface.

2-10. Isotropic means they have the same properties in all direction. Anisotropic means they just have the same properties in the same direction, the properties may change with direction.
Heat generation in a solid means that conversion of some form of energy into thermal energy happened in solid medium. For example, battery converts part of its chemical energy into thermal energy when it works.

Heat generation refers to thermal energy generation. Actually, energy can't be generated. It just can be transformed each other. Heat generation means that other kind of energy transforms to thermal energy.
2-14. Given \( \dot{Q} = 1000 \text{ W} \)
\[ D = 0.08 \text{ in} \]
\[ L = 15 \text{ in} \]

To find \( \dot{q} \)

Solution \( \dot{q} = \frac{\dot{Q}}{V} = \frac{4\dot{Q}}{\pi D^2 L} = \frac{4 \times 1000 \text{ W}}{\pi \cdot (0.08 \text{ in})^2 \cdot 15 \text{ in}} \)

\[ = 8.09 \times 10^8 \text{ W/m}^3 \]

\[ = 7.822 \times 10^7 \text{ btu/h ft}^3 \]

2-18 Given \( \dot{q} = \dot{e}_0 e^{-bx} \)
\[ A = A \]
\[ L = L \]

To find \( \dot{Q} \)

Solution \( \dot{Q} = A \int_0^L \dot{q} \, dx = A \dot{e}_0 \int_0^L e^{-bx} \, dx \)

\[ = \frac{A \dot{e}_0}{b} \left[ e^{-bL} - e^{-b0} \right] \]

\[ = \frac{A \dot{e}_0}{b} (1 - e^{-bL}) \]
1-d transient heat conduction for plane

\[
\frac{\partial^2 T}{\partial x^2} + \frac{\dot{e}_{gen}}{k} = \frac{1}{\alpha} \frac{\partial T}{\partial t}
\]

T: temperature

t: time

x: distance.

k: thermal conductivity of material

\(\alpha\): the thermal diffusivity of material

\(\dot{e}_{gen}\): the rate of heat generation