A service technician is working on a piece of high-tech manufacturing equipment, when a high temperature line suddenly ruptures. The skin of her arm is sprayed with 10 g of water at a temperature of 100 celsius. Will it make any difference to her injuries whether the water is in a liquid or gaseous state (i.e., steam)? Explain.

Is heat capacity the only consideration?

Thinking about the equation for heat transfer which is Q = mc (delta T), the mass and the temperature are both constant. From there, we have the specific heat left. **The specific heat for water is significantly larger than that of steam.** More heat would be transferred from the liquid meaning a worse injury.

Key difference: steam liberates a lot of energy when it becomes liquid

There will be a difference to her injuries depending on if the state of water is liquid or solid. The water will cause injury but that is until the cooling process is finalized. The process is reflective of the temperature gradient (the difference between the temp of skin and water) between the skin and water. The steam will cause more detrimental injuries then the water because of the higher energy transfer between the steam and the skin as a phase change occurs from steam to water upon contact to the skin.

Yes, the phase at which the water is in will make a difference in the level of injury she has. This mainly has to do with latent heat (of vaporization). Because the steam produces latent heat when in contact with the skin, the technician endures more heat overall compared to the liquid.

Your body radiates an average of 100 W of power continuously. If energy continued to be lost at that rate but the internal biochemical processes providing that energy suddenly stopped, estimate how much your temperature would change in one hour? Treat the human body as predominantly composed of water (specific heat = 4186 J/kg C). Hint: Recall that power is the rate of energy usage per time and 1 W = 1 J/s.

Good logic, but bad to use a calculator

For this, I think we need to use the same formula of heat transfer which is Q = mc(delta T). Because 1W = 1 J/s, we can convert 100 W to 100 J/s which is also equal to Q/t. The average person weighs 70 kg, and it is given that the specific heat is 4186 J/kg C. Now, we can say mc(delta T)/t = 100 J/s. Plugging in, (70 kg)(4186 J/kgC)(delta T)/3600s = 100 J/s. This gives us delta T = 1.23 degrees Celsius. Since energy is being lost, the change in temperature is negative, so the final answer is -1.23 degrees Celsius.

Good logic and good use of approximation, though steps aren't shown

Knowing that the body radiates 100 W of power and that power is the rate at which energy is used per time, 100 W is equal to 100 J / s. In one hour the body will have lost approximately 360,000 J (knowing that there are 3600 seconds in an hour). Using the equation Q = mc delta T and approximating an average human body mass of 60 kg,

360,000 J = (60kg)(4186 J/kg)(deltaT).

Therefore, the body's temperature would decrease by **approximately** one degree Celsius every hour.