Always, Sometimes, or Never True

For each of the following statements, work out in your group whether it is *never true*, *sometimes true* or *always true*. Explain why your answer is correct, being specific about what fundamental laws are responsible. If it is only sometimes true, try to give examples of each case.

Hot object in cool water If I put a hot object (of any material) into a tub of colder water without changing its pressure:

1. The temperature of the object will decrease.
2. The internal energy of the object will decrease.
3. The entropy of the object will decrease.
4. The volume of the object will decrease.
5. The entropy of the object plus the entropy of the water will increase.

Identical objects Consider two identical objects A and B, which could be of any material, and are of the same mass, but are subject to different conditions (pressure, temperature).

1. If A has higher volume than B, then A has higher entropy.
2. If A has higher temperature than B, then A has higher internal energy.
3. If A has higher temperature than B, but they have the same volume, then A has higher internal energy.
4. If A has higher temperature than B, but they have the same pressure, then A has higher internal energy.
5. If A has higher temperature than B, but they have the same pressure, then A has higher enthalpy. ($H = U + pV$)
6. If A has higher temperature than B, but they have the same pressure, then A has higher entropy.

Bag of hot air? Consider an insulated spherical bag full containing a fluid—which could be either liquid or solid. The bag is very strong, so it cannot be stretched, and also happens to be an excellent thermal insulator.

1. If I sit on the bag, it will no longer be spherical.
2. If I sit on the bag, the pressure of the bagfull of fluid will increase.
3. If I sit on the bag, the volume of the bagfull of fluid will increase.
4. If I sit on the bag, the temperature of the bagfull of fluid will increase.
5. If I sit on the bag, the entropy of the bagfull of fluid will increase.
6. If I sit on the bag, the internal energy of the bagfull of fluid will increase.
7. If I sit on the bag, the enthalpy of the bagfull of fluid will increase.
8. If I sit on the bag, the Helmholtz free energy of the bagfull of fluid will increase.

Aluminum balloon? Consider a similar spherical bag that is an excellent thermal conductor. In this problem, assume that my bottom is at room temperature—perhaps because I'm wearing asbestos undergarments.

1. If I sit on the bag and wait a while, it will no longer be spherical.
2. If I sit on the bag and wait a while, the pressure of the bagfull of fluid will increase.
3. If I sit on the bag and wait a while, the volume of the bagfull of fluid will increase.
4. If I sit on the bag and wait a while, the temperature of the bagfull of fluid will increase.
5. If I sit on the bag and wait a while, the entropy of the bagfull of fluid will increase.
6. If I sit on the bag and wait a while, the internal energy of the bagfull of fluid will increase.
7. If I sit on the bag and wait a while, the enthalpy of the bagfull of fluid will increase.
8. If I sit on the bag and wait a while, the Helmholtz free energy of the bagfull of fluid will increase.

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