PHYSICS EXAM

1. A certain amount of air is *cooled* inside a cylinder with piston. (The air may be expanded or compressed.) The process runs reversibly. Which is the only statement which can be made with certainty?
   - ❏ its entropy decreases
   - ❏ its temperature decreases
   - ❏ its pressure decreases
   - ❏ its volume stays constant
   - ❏ its energy stays constant
   - ❏ its energy decreases

   Explanation:..
   ....
   ....

2. The specific energy capacity (specific heat) of glycol is given approximately by $c = a + bT$ (a = 560 J/(K·kg), b = 6.0 J/(K^2·kg), T in Kelvin). At 100°C we have:
   - ❏ specific energy capacity = 1160 J/(K·kg)
   - ❏ specific energy capacity = 2798 W/(K·kg)
   - ❏ specific entropy capacity = 27.98 J/(K^2·kg)
   - ❏ specific entropy capacity = 7.50 J/(K^2·kg)

   Explanation:..
   ....
   ....

3. Air is compressed *adiabaticaly*, whereby the process runs *irreversibly*. In the *T–S* diagram the process curve runs
   - ❏ horizontally to the left
   - ❏ vertically upward
   - ❏ downward to the left
   - ❏ upward to the right

   Explanation:..
   ....
   ....

4. A house has an energy conductance of 300 W/K. Inside the temperature is 20°C, outside it is 0°C. The *entropy* flow from the air inside through the wall is
   - ❏ 6000 W/K
   - ❏ 20.5 W/K
   - ❏ 2050 W/K
   - ❏ 6000 W
   - ❏ 300 W/K

   Explanation:..
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5. Hot water is cooling in a thin walled aluminum can with a surface of 0.030 m^2. The convective heat transfer coefficient at the surface (metal to air) is 10 W/(K·m^2). At a certain moment the energy current is 20 W. The temperature of the air is 20°C. What is the approximate surface temperature of the can?
   - ❏ 22°C
   - ❏ 96°C
   - ❏ 65°C
   - ❏ 40°C
   - ❏ 87°C

   Explanation:..
   ....
   ....

SOLUTIONS

1. A certain amount of air is *cooled* inside a cylinder with piston. (The air may be expanded or compressed.) The process runs reversibly. Which is the only statement which can be made with certainty?
   - ✔ its entropy decreases
   - ❑ its temperature decreases
   - ❑ its pressure decreases
   - ❑ its volume stays constant
   - ❑ its energy stays constant
   - ❑ its energy decreases

   Explanation: *Cooling* means *emission of entropy*. If the process is reversible, emission leads to a *reduction* of the stored entropy. (What happens to the other variables depends on the details of the process.)

2. The specific energy capacity (specific heat) of glycol is given approximately by $c = a + bT$ (a = 560 J/(K·kg), b = 6.0 J/(K^2·kg), T in Kelvin). At 100°C we have:
   - ❑ specific energy capacity = 1160 J/(K·kg)
   - ❑ specific energy capacity = 2798 W/(K·kg)
   - ❑ specific entropy capacity = 27.98 J/(K^2·kg)
   - ✔ specific entropy capacity = 7.50 J/(K^2·kg)

   Explanation: c = 560 J/(K·kg) + 6.0 J/(K^2·kg)·373 K = 2798 J/(K·kg) (wrong unit for answer 2!). $k = c/T$ = 2798 J/(K·kg) / 373 K = 7.50 J/(K^2·kg).

3. Air is compressed *adiabaticaly*, whereby the process runs *irreversibly*. In the *T–S* diagram the process curve runs
   - ❑ horizontally to the left
   - ❑ vertically upward
   - ❑ downward to the left
   - ✔ upward to the right

   Explanation: Adiabatic (no entropy flows) compression leads to an increase in temperature. Irreversibility (production of entropy) leads to an increase of entropy stored.

4. A house has an energy conductance of 300 W/K. Inside the temperature is 20°C, outside it is 0°C. The *entropy* flow from the air inside through the wall is
   - ❑ 6000 W/K
   - ✔ 20.5 W/K
   - ❑ 2050 W/K
   - ❑ 6000 W
   - ❑ 300 W/K

   Explanation: $I_S = I_{W,th} / T = G_W(T_1 - T_2) / T_1$ = 300 W/K ·(293 – 273) K / 293 K = 20.5 W/K.

5. Hot water is cooling in a thin walled aluminum can with a surface of 0.030 m^2. The convective heat transfer coefficient at the surface (metal to air) is 10 W/(K·m^2). At a certain moment the energy current is 20 W. The temperature of the air is 20°C. What is the approximate surface temperature of the can?
   - ❑ 22°C
   - ❑ 96°C
   - ❑ 65°C
   - ❑ 40°C
   - ✔ 87°C

   Explanation: $I_{W,th} = G_W(T_1 - T_2)$, therefore $T_1 = T_2 + I_{W,th}/G_W$ = 20°C + 20 W / (0.030 m^2 · 10 W/(K·m^2)) = 87°C.