Quiz 9

Due Nov 16 at 10am **Points** 80 **Questions** 9
Available Nov 15 at 10am - Nov 16 at 10am 1 day **Time Limit** 30 Minutes
Allowed Attempts 2

Instructions

This quiz covers the material from class up to and including Nov 12.

You have 30 minutes to take the quiz and you can take it twice if you like.

Come to office hours on Monday at 9-9:45pm to ask your quiz questions.

Henriette

Attempt History

	Attempt	Time	Score
KEPT	Attempt 2	11 minutes	40 out of 80 *
LATEST	Attempt 2	11 minutes	40 out of 80 *
	Attempt 1	4 minutes	40 out of 80 *

* Some questions not yet graded

ⓘ Correct answers are hidden.

Score for this attempt: **40** out of 80 *
Submitted Nov 16 at 2:52am
This attempt took 11 minutes.

Question 1 — 0 / 0 pts

I certify that I am me and that I am taking this quiz on my own, without help from others. Between my two attempts, I know I can Henriette questions ask in office hours and via Piazza if I need clarification. My answers will reflect my own understanding and I will not copy answers from others.

Absolutely!

Question 2

Not yet graded / 10 pts

Consider a refrigerator in room. The refrigerator is connected to a power outlet and is running, but someone forgot to close the refrigerator door!! Does the room warm up or cool down? Argue for your answer in terms of what you have learned in this class.

Your Answer:

Denote the amount of heat that is taken out from the refrigerator as $|Q_c|$, and denote the amount of heat that is added to the room as $|Q_h|$ as part of of the cooling process. Denote the amount of work done by this process as $|W|$. The door of the refrigerator is open, so the amount of heat taken out from the room is just the same as $|Q_c|$. By the First Law of Thermodynamics, we have $|Q_h|=|W|+|Q_c|$, by the Second Law of Thermodynamics, we have $|W|>0$, so we know that $|Q_h|>|Q_c|$, that is, we know that the amount of heat added to the room is greater than amount of heat removed from the room. So we know that the room becomes warmer.

Question 3

10 / 10 pts

Consider a refrigerator based on an Otto cycle run in reverse. If the ratio of the largest volume to the smallest in the cycle is 2.50 and the working substance of the cycle is a diatomic gas, then what is the coefficient of performance?

- 1.188
- 0.307
- 2.26
- 1.721

- 0.339
- 0.457

Question 4

10 / 10 pts

Which of the following processes can proceed in a way that is reversible?

- [x] Ice melting at 0 degrees Celsius
- [ ] A car stopping by using its brakes
- [ ] Ice melting a room temperature
- [x] Slowly mixing hot water and cold water in small steps
- [ ] Mixing a blue liquid with a red liquid at the same temperature
- [ ] Slowly mixing hot coffee and cold milk in small steps

Question 5

Not yet graded / 15 pts

N molecules of helium are initially at a state with pressure *p* and *V.* The gas undergoes some thermodynamic process and in the final state it it has doubled both the pressure and tripled the volume. The resulting change in entropy for the gas can be expressed as $N\,k\,\ln(a)$ where k is Boltzmann's constant.

Compute the number *a.*

Write out your reasoning in detail, explain what you do to find the answer.

Your Answer:

The gas undergoes some thermodynamic process and it has its final state doubled the pressure and tripled the volume. Here the process can be broken down into a

combination of an isobaric process that increases the volume of the gas from V to 3V, and an isochoric process that increases the pressure of the gas from p to 2p. The change of the entropy of the gas is path independent, hence we know that the change of the entropy of the gas is the sum of the changes of entropy in the isochoric and the isobaric process. Then we can write

$\Delta S_{total} = \Delta S_{isoch.} + \Delta S_{isoba.}$,

where

$\Delta S_{isoch.} = \int dQ/T = \int n C_v dT/T = n C_v \ln(2p/p) = n C_v \ln(2)$

and

$\Delta S_{isoba.} = \int dQ/T = \int n C_p dT/T = n C_p\ln(3V/V) = n C_p\ln(3)$

Hence we know that

$\Delta S_{total} = nC_v \ln(2)+ nC_p\ln(3)$

$= nR(3/2)\ln(2) + nR(5/2)\ln(3) = Nk\ln(2^{3/2} + 3^{5/2})$.

So we see that $a=2^{3/2}+3^{5/2}$.

Question 6

10 / 10 pts

Which of the following statements are TRUE?

- [ ] An adiabatic process typically proceeds very slowly to minimize the friction and thereby minimize heat exchange
- [x] An adiabatic process typically proceeds very quickly to minimize the time for any heat exchange
- [ ] All reversible processes are also adiabatic

- [x] A reversible process typically proceeds slowly in tiny steps that can be reversed
- [ ] A reversible process typically proceeds very quickly to avoid any irreversible aspects.
- [ ] All adiabatic processes generate positive work.
- [ ] A reversible process typically proceeds very quickly to avoid friction and heat exchange

Question 7

Not yet graded / 5 pts

Consider the spontaneous flow of heat from a hot object to a cooler one. Considering only the warmer object it is losing heat so the change in entropy for this object is negative.

Does this violate the 2nd law of thermodynamics? Why / why not? Explain your answer.

Your Answer:

This does not violate the second law of thermodynamics. There is a spontaneous heat flow because there is a temperature difference between the warmer object and the cooler object, the increase in temperature of the cooler object will cause the entropy of the cooler-warmer-object system to increase. While the warmer object cannot be itself an isolated system because there will not be spontaneous heat flow when the system is the warmer object itself, so this does not violate the second law.

Question 8

Not yet graded / 10 pts

In HW9 you studied the Stirling cycle and found that when regenerating is used, its efficiency computes to be the same as for the Carnot cycle. However, where the

Carnot cycle is truly reversible, the Stirling cycle is not, when the full system including the heat baths are taken into account. Why not?

Explain your answer.

Your Answer:

Since adiabatic processes involves no heat exchange, then the entropy change in such process is zero, so this process is reversible. On the other hand, isothermal processes is reversible because temperature is constant throughout the process (no spontaneous heat flow occur). Carnot cycle only has isothermal and adiabatic processes, so it is truly reversible. However, Stirling cycle has two isochoric processes, and in isochoric processes, heat exchange is non-zero and hence the change in entropy is non-zero, which makes the process irreversible, so we know that the Stirling cycle is irreversible.

Question 9

10 / 10 pts

Which of the following statements are TRUE?

- [ ] Boltzmann's formula says the entropy of configuration can never be zero
- [ ] The entropy of the Universe is constant and the energy is increasing
- [ ] As the Universe expands, the temperature of the Cosmic Microwave Background goes down, hence the energy of the Universe is decreasing
- [x] The energy of the Universe is constant and the entropy is non-decreasing
- [ ] Boltzmann's formula is only valid for reversible processes
- [x] For fixed n moles of water, there are more microstates in steam than in liquid water
- [x] Boltzmann's formula implies that the change in entropy is path independent

- [ ] As the Universe expands, the temperature of the Cosmic Microwave Background goes down, hence the entropy of the Universe is decreasing

- [x] For fixed n moles of water, there are more microstates in liquid water than in ice

- [x] As the Universe expands, disorder is increasing

Quiz Score: **40** out of 80