Quiz 3.1 – Entropy

Name: _____

**Carnot cycle**

Consider a heat engine based around the Carnot cycle. Sketch this cycle on a p/V diagram, labeling the states in the process as A, B, C, and D

Tell which direction around this cycle operates as a heat engine, and which direction operates as a heat pump

- A-B-C-D-A:
- A-D-C-B-A:

Fill in the table below for the cycle when operating as a heat engine. Use generic variables ($C_V$, $T_H$, $T_C$, $V_A$, $V_B$, etc.)

| Step | $w$ | $q$ | $\Delta U$ | $\Delta S$ |
|---|---|---|---|---|
| A-B | | | | |
| B-C | | | | |
| C-D | | | | |
| D-A | | | | |
| net (A-B-C-D-A) | | | | |

A car engine is a type of heat engine, and burns gasoline burns at about $600\ ^\circ C$. If the ambient temperature is $25\ ^\circ C$, what is the thermodynamic maximum efficiency a car engine can achieve?

**Measuring molar entropy**

He has $T_{boil} = 4.25\ K$ and $\Delta H_{vap} = 83\frac{J}{mol}$. The isobaric heat capacity for liquid helium is very complex, but can be approximated as $C_p(l) \approx 7.4 \times 10^{-3} T^3 \frac{J}{mol\ K^4}$. The isobaric heat capacity for gaseous He is simply $C_p(g) = \frac{5}{2}R$. Use these data to calculate the molar entropy for He gas at room temperature, and compare it to the value given in our textbook appendix.

**Irreversibility in Mechanical Systems**

Consider a spring which obeys Hook's law: $F = -kx$ where $x$ is the displacement away from equilibrium and $k = 650\frac{N}{m}$. The acceleration due to gravity is $9.80665\ \frac{m}{s^2}$.

- Calculate the equilibrium displacement if a $10\ kg$ weight is placed on the spring

Considering the same weight-on-a-spring in Problem 1:

- Calculate the work done by the falling weight.

How much work would be done if instead the spring was stretched reversibly to the same equilibrium displacement. Bonus – Explain the discrepancy!

The spring-weight system will lose kinetic energy through friction with the air until it rests at its equilibrium position. What is $\Delta S_{universe}$ for both the reversible and irreversible processes if they are done at room temperature $(25°C)$?

*Who Has Seen the Wind?*

**By Christina Rossetti**

Who has seen the wind?
Neither I nor you:
But when the leaves hang trembling,
The wind is passing through.

Who has seen the wind?
Neither you nor I:
But when the trees bow down their heads,
The wind is passing by.