Physics 2020

REVIEW SET FOR MIDTERM 1

1. 5.0 moles of an ideal gas, initially at a temperature of 350°K and pressure $1.5 \times 10^5$ N/m$^2$ are expanded isobarically. During the expansion the volume of the gas increases to double its initial volume.

A. Determine the initial volume of this ideal gas.
B. Determine the work done by the gas during the expansion.
C. By how much did the initial energy of the gas change during the expansion?
D. How much heat, Q, was added to (or removed from) the gas?
E. If the same process were carried out isothermally instead of isobarically, would the answers to B, C and D above be more, less or equal to the original answers, or cannot tell the direction of the change will be. Respond by filling in the table with the correct symbol (pictured).

<table>
<thead>
<tr>
<th>Response</th>
<th>W</th>
<th>ΔU</th>
<th>Q</th>
</tr>
</thead>
</table>

1 = increase | 1 = decrease | 0 = no change | $X =$ can't tell

2. The figure shown is a PV diagram that consists of a pair of constant volume processes (DA and BC) and a pair of adiabatic processes (AB and CD)

A. The following table is partially filled in with thermal data about the cycle. Complete the table.

<table>
<thead>
<tr>
<th>W</th>
<th>Q</th>
<th>ΔU</th>
</tr>
</thead>
<tbody>
<tr>
<td>DA</td>
<td>0</td>
<td>18,000 J</td>
</tr>
<tr>
<td>AB</td>
<td>0</td>
<td>-10,000 J</td>
</tr>
<tr>
<td>SC</td>
<td>-12,000 J</td>
<td></td>
</tr>
<tr>
<td>CD</td>
<td>-4,000 J</td>
<td></td>
</tr>
</tbody>
</table>

B. What is the thermal efficiency of this cycle?
C. Determine the sum of all the internal energy changes for all the steps in the cycle.
D. If this system were redesigned to operate so that $Q_h$ were absorbed at 1000°C and the heat removed, $Q_c$, was removed at 15°C, what would be the ideal (Carnot) efficiency of this redesigned system?

3. A heat engine operates at an actual efficiency of 42.2% with a high temperature reservoir of 473 K. In each cycle the engine does 250 J of work. Operating as a reversible (ideal engine) this particular engine is capable of doing 444 J of work with the same input heat $Q_h$.

A. What is the ideal (Carnot) efficiency of this engine?
B. What is the Kelvin temperature of the low temperature reservoir assuming the engine is operating ideally?
C. Suppose the heat engine described above is already operating ideally, i.e., 44.2% is the ideal efficiency. To what temperature would the high temperature reservoir have to be lowered to get this 44.2% efficiency without changing $T_c$?
4. Starting at point A 2.00 moles of an ideal monatomic gas are taken through a 3-step cycle, A → B → C → A shown on the PV diagram. The process B → C is an isothermal expansion. \( W_{BC} = 6280 \text{ J} \).

A. Determine \( W \), \( Q \), and \( \Delta U \).

B. Fill in the missing information in the table below. SHOW WORK BELOW.

<table>
<thead>
<tr>
<th></th>
<th>( W )</th>
<th>( Q )</th>
<th>( \Delta U )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A → B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B → C</td>
<td>6280 J</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C → A</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. A certain amount of an ideal gas is taken around the cycle shown in the PV plot below. Point A on the plot is the starting and finishing point of the cycle. The following data are also known: \( \Delta U_{BC} = -9.0 \times 10^5 \text{ J} \) and \( Q_{AB} = 4.0 \times 10^5 \text{ J} \).

A. Determine the work done during each step of the cycle, i.e., \( W_{AB} \), \( W_{BC} \) and \( W_{CA} \).

B. Determine the net work done during the cycle.

C. Determine the net change in internal energy and the net heat added (or lost) for the cycle.

D. Finally, from the data and the results of parts A, B and C fill in the blanks below.

\[
\Delta U_{AB} = \quad \quad \quad \quad \quad \quad Q_{BC} = \\
\Delta U_{CA} = \quad \quad \quad \quad \quad \quad Q_{CA} = 
\]

6. Problem #5 describes an ideal gas taken through a cyclic process. Let’s now assume that cycle is the basis of an operating heat engine. From the work on the previous problem copy down in the space provided the net work done during the cycle.

\[
W_{net} = \\
Q_{AB} = \\
Q_{BC} = \\
Q_{CA} = \\
\]

A. Determine \( Q_{\text{net}} \), the total amount of heat added to the gas.

B. What is the actual efficiency of this cycle acting as a heat engine?

C. Suppose this heat engine is operating between a pair of high and low temperature heat reservoirs at \(-223^\circ\text{C}\) and \(475^\circ\text{C}\), respectively. What is the ideal efficiency of this engine?
7. 2.48 moles of Ar, Argon, are placed in a cylindrical vessel whose initial volume is fixed at 0.0440 m³. The pressure the gas exerts is 1.88 × 10⁵ N/m². \( M_{\text{Ar}} = 40.0 \).

A. Calculate how many atoms of Ar and what total mass of Ar are present in the container.
B. What is the Kelvin temperature of the gas in the container?
C. What is the total internal energy of the Ar gas and what is the average kinetic energy of the Ar atoms?
D. Suppose an additional mole of Ar is added to the container while keeping the volume and temperature the same. By what factor does the average particle speed of the Ar atoms change? Be sure to indicate whether that average speed has increased, decreased or did not change.
E. Suppose the Ar gas is replaced by an identical number of moles of N₂ gas \( M_{\text{N₂}} = 28.0 \) keeping the pressure and volume the same as it was for the Ar gas. Next to each item below place the word, larger, smaller or unchanged to indicate the difference with N₂ present than Ar.
   1. total mass: _________________________
   2. number of particles: _________________________
   3. temperature of the gas: _________________________
   4. average kinetic energy per particle: _________________________

8. In a 10.0 ℓ vessel is an amount of an ideal gas at a temperature of 27.0°C and a pressure of 1.65 × 10⁵ N/m².

(a) How many particles of ideal gas occupy the container?
(b) If the gas is helium, He, what mass of He is in the vessel? \( M_{\text{He}} = 4.00 \text{ gm/mole} \)
(c) If the vessel were now heated to 127°C, what would be the new pressure exerted by the gas?
   Assume the volume the gas occupies does not change, nor does any gas escape from the vessel.

9. Rewrite the data given in the previous problem.

\[ V = 10.0 \text{ ℓ}; \ T = 27.0°C; \quad P = 1.65 \times 10^5 \text{ N/m}^2 \]

(a) Determine the speed of an average (RMS value) He atom in the container. From the previous problem \( M_{\text{He}} = 4.00 \text{ gm/mole} \).
(b) With the temperature of the gas in the vessel increased to 127°C, would the average particle speed increase or decrease? By what factor? That is, compute the ratio of the average speed at the initial \( T \) to be the average speed of the final \( T \).
(c) The gas in the vessel is now removed and replaced with an equal number of N₂ particles. By what factor (a ratio calculation) would the average speed (i.e., the RMS velocity) change with the new gas relative to the average speed of the original gas. Be sure to indicate which gas particles travel faster. Note: \( M_{\text{N₂}} = 28.0 \text{ gm/mole} \). Assume the conditions are arranged so that the pressure exerted by the new gas is maintained at the same 1.65 × 10⁵ N/m² as the original gas, and the vessel's volume does not change. Justify your answer.

10. A car moves with speed 17.0 m/s toward a stationary wall. Its horn emits 200 Hz sound waves, which move at 340 m/s.

A. Find the wavelength of the sound in front of the car and the frequency with which the waves strike the wall.
B. Since the waves reflect off the wall, the wall acts as a source of sound waves at the frequency found in the previous question. What frequency does the driver of the car hear reflected from the wall?
C. The horn emits sound uniformly in all directions with power 4.00 watts. Find the sound intensity at a distance of 10.0 meters from the car.
D. Find the intensity level in decibels at that distance.
11. A. The plot shows the displacement vs. position of a longitudinal repetitive wave traveling in the positive x direction. The speed of the wave is 1000 m/s. Points A, B, C, etc. mark different points in space through which the wave is traveling.

1. The wavelength of this wave is ____________
2. The amplitude of this wave is ____________
3. The frequency of the wave is ____________
4. The period of the wave is ____________

On the empty graph below plot the displacement vs. time of the medium at the spatial point B from above. You may assume at time t = 0 the particle of the medium is at its equilibrium position moving with maximum positive velocity. Be sure to write in numbers for scale values.

B. Waves are caused to move to the right along a very long cable under the influence of a fixed frequency vibrator as shown in the figure. Answer the following with increase, decrease, remains the same, or cannot tell.

1. ____________ The wavelength of the waves on the cable if the tension on the cable is increased.
2. ____________ The frequency of the waves on the cable if a more dense cable is used (same tension).
3. ____________ The speed of the waves on the cable if the tension is reduced.
4. ____________ The wavelength of the waves on the cable if the length of the cable is increased.
5. ____________ The period of the waves on the cable if both the tension in the cable and the cable density are doubled.
6. ____________ The speed of the waves on the cable if a new cable made of the same material as the old cable is used with the cross-sectional area doubled.

12. A pneumatic jackhammer (a device for breaking up concrete) has an intensity level of 110 dB at 2.00 m from the device.

A. Determine the power output assuming the jackhammer behaves as a point source.
B. How far away would an observer have to be for the intensity level to be 80.0 dB?
C. Assume 2 additional and identical jackhammers start working on the same section of concrete, at pretty much all at the same spot, how far away from this group would an observer have to be to hear the same intensity level of a single jackhammer produced at 2.00 m? Assume the jackhammer intensities add.
13. A. A siren is producing sound **uniformly in all directions** at \( f = 900 \text{ Hz} \). At 100 m from the siren the intensity level is 80 dB. A detector is moved to a new position where the intensity level is 60 dB.

1. What is the intensity of the siren at the new position?
2. How far away from the siren is the new position?

B. A pedestrian standing at an intersection hears a fire engine siren vary in frequency from 476 Hz when the engine is coming towards her and 404 Hz when it is moving away from her. Take the speed of sound in air to be \( v = 343 \text{ m/s} \). What is the speed of the fire engine?

![Fire engine engine images](image)

\[ f = 476 \text{ Hz} \quad f = 404 \text{ Hz} \]

14. A Boeing 757 is beginning to take-off from the Salt Lake Airport. A construction worker standing next to the runway observes that when the jet is 1000 m away, the intensity of the sound is \( 4.0 \times 10^2 \text{ W/m}^2 \). Assume the sound from the jet radiates isotropically (same in all directions).

A. What is the average power output of the 757 as a sound producer?
B. By what factor has the intensity increased when the jet is 100 m from the construction worker.
C. What are the decibel (dB) readings at the 1000 m mark and at the 100 m?
D. Assume that when the plane is at the 1000 m distance from the worker it is traveling at 60 m/s and the dominant sound frequency the jet engine produces is 250 Hz (as heard by the pilot). What is the predominant frequency the worker hears? Use \( v(\text{sound}) = 340 \text{ m/s} \).

15. A reversible 3-step cycle is carried out on one mole of an ideal gas. The steps of the cycle are:

A. an isochoric pressure increase at volume \( V_1 \) from pressure \( P_1 \) to \( P_2 \)
B. an isothermal compression from \( P_3 \) and \( V_1 \) to pressure \( P_4 \) and volume \( V_3 \)
C. an adiabatic expansion back to the starting point at pressure \( P_1 \) and volume \( V_1 \)

A. Draw the P-V diagrams for this cycle on the graph below.

![P-V diagram](image)

B. In the table below enter “+”, “-” or “0” to indicate the value of the requested quantity or the change in the value of the requested quantity.

<table>
<thead>
<tr>
<th>Quantity/Process</th>
<th>( W )</th>
<th>( Q )</th>
<th>( \Delta U )</th>
<th>Change in ( v_{RMS} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whole Cycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C. In the questions below write start, end of A, and/or end of B to best answer the query.
1. _______ The state at lowest temperature.
2. _______ The state at which the average KE per particle is greatest.

D. Is this thermodynamic cycle acting like a heat engine or a refrigerator?

16. A. On top of the police station in a small Kansas town sits a siren that emits a 1.00 kHz tone as a spherical isotropic emitter with an average power $P_{av} = 1.257 \times 10^{-3}$ W. The police chief, Dorothy Overbow, is initially at a direct line of sight distance from the siren such that she just hears the siren at the threshold of human hearing, i.e., $I_{threshold} = 1.00 \times 10^{-12}$ W/m$^2$.

1. How far is Dorothy from the siren?
2. What is the intensity level, $\beta$, for the sound from the siren at Dorothy’s initial position?
3. Dorothy jumps in her cruiser and takes off toward the police station heading directly toward it at 30.0 m/s. While traveling with that velocity, what frequency of the sound coming from the siren does Dorothy hear? Use $v(sound) = 340$ m/s.
4. When Dorothy reaches a point halfway to the police station from where she started, what would be the intensity level, $\beta$, of the sound coming from the siren?

17. A. Examine the plots showing either displacement vs. times or displacement vs. positions of waves moving along the +x direction in the same medium

(a) ![Graph (a)](image)
(b) ![Graph (b)](image)
(c) ![Graph (c)](image)
(d) ![Graph (d)](image)
(e) ![Graph (e)](image)
(f) ![Graph (f)](image)

To fill in the blanks below you will have to do some quick calculations of the targeted quantities based upon graphical data.

1. _______ is the wave with the smallest frequency.
2. _______ is the wave with the largest frequency.
3. _______ is the wave with the smallest wavelength.
4. _______ is the wave with the largest wavelength with a wave speed of 10 m/s.
5. _______ is the wave with the smallest period.
6. _______ is the slowest moving wave whose amplitude is 2.0 cm.
B. The following diagram is a PV plot of a three step thermodynamic cycle in which an ideal gas, starting at point A is taken through the cycle ABCA. In the table below, enter “+”, “−”, or “0” to indicate whether the requested quantity is positive, negative, or zero.

<table>
<thead>
<tr>
<th></th>
<th>W</th>
<th>ΔU</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>A → B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B → C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C → A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entire Cycle</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18. A. Imagine you are in your car waiting for a left turn light to go from red to green when an oncoming car passes through the intersection without turning, its horn blowing continuously and traveling with a constant speed v. As the oncoming car approaches, the frequency of the horn is 653 Hz and after the car passes you and is receding away down the street, its frequency is 547 Hz. What is the constant speed of the passing car? Take the speed of sound to be 343 m/s.

B. In an audition for a role in an opera the soprano produces a sound that registers 110 dB on a sound level meter. How many identical sopranos singing the same note together would it take to produce a sound that would register 120 dB on the sound level meter? You must show work.

19. 4.00 moles of an ideal monatomic gas is taken through an unusual 3-step cycle shown in the accompanying figure. Pertinent data for the cycle is to the right of the PV diagram.

<table>
<thead>
<tr>
<th></th>
<th>T</th>
<th>P</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>273 K</td>
<td>1.01 \times 10^5 \text{N/m}^2</td>
<td>0.0899 \text{m}^3</td>
</tr>
<tr>
<td>B</td>
<td>2188 K</td>
<td>4.04 \times 10^5 \text{N/m}^2</td>
<td>0.180 \text{m}^3</td>
</tr>
<tr>
<td>C</td>
<td>547 K</td>
<td>1.01 \times 10^5 \text{N/m}^2</td>
<td>0.180 \text{m}^3</td>
</tr>
</tbody>
</table>

A. Fill in all the blank entries in the table below. Be very careful with signs. There will be large point deductions for incorrect signs. Use back of page if you need additional space.

<table>
<thead>
<tr>
<th></th>
<th>ΔU</th>
<th>B → C</th>
<th>C → A</th>
<th>Whole Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>A → B</td>
<td></td>
<td>- 8.18 \times 10^4 \text{J}</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>2.48 \times 10^4 \text{J}</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. Is the device based on the cycle described in this problem behaving as a heat engine or refrigerator?
20. A. A tsunami warning siren behaving as an isotropic spherical sound source, has an intensity level of 100.0 dB at 6.00 m. Note: $I_s = 1.00 \times 10^{-12}$ W/m$^2$

1. What is the average intensity of the siren at 6.00 m?
2. What is the intensity level in dB of the siren at a distance of 120 m?
3. Suppose a second identical siren is located right next to the original siren. What would now be the intensity level in dB of the 2-siren system at the original 6.00 m?

B. A police cruiser is proceeding south on I-15 at 52.0 m/s in a high speed chase of a stolen car which is traveling south on I-15 at 40.0 m/s. The siren on the cruiser produces sound at a single 1500 Hz frequency, as heard by the driver of the cruiser. Take $v_{\text{sound}} = 340$ m/s.

1. What is the frequency of the siren heard by the driver of the stolen car?
2. At what speed would the driver of the stolen car have to travel in order to hear the siren at 1500 Hz?
3. If the driver of the stolen car starts slowing down while the police cruiser maintains its 52.0 m/s speed, will the frequency of the siren tone, as heard by the driver of the stolen car, increase, decrease, or stay the same?

21. A. The following is a PV plot of a 3-step thermodynamic cycle in which an ideal gas starting at point A is taken through the cycle ABCA. On the table enter “+”, “−”, or “0” to indicate whether the requested quantity is positive, negative, or zero.

<table>
<thead>
<tr>
<th></th>
<th>W</th>
<th>$\Delta U$</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>A → B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B → C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C → A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entire cycle</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. ________ Is net heat added or removed from the gas?
2. ________ Could this cycle be used in refrigeration? (Enter either yes or no.)

B. Two different ropes are separately tied to a wall, held taut, and yanked continuously up and down. Waves, as shown, are sent traveling to the right along each rope with speeds $v_A$ and $v_B$ ($v_A > v_B$). See drawing. Select the statements below that could account for $v_A > v_B$ by placing a check mark in the blank space of those that could and leaving blank those that could not.

1. ________ The linear density of rope A is less than that of rope B.
2. ________ The yanking frequency for rope A is greater than that for B.
3. ________ The wavelength of the wave on rope A is greater than that on B.
4. ________ The tension in rope A is greater than the tension in B.
5. ________ The linear density of rope A is greater than that of rope B.
6. ________ The tension in rope A is less than the tension in B.
22. 2.40 moles of a monatomic ideal gas, initially at STP, i.e., \( T = 273 \text{ K} \) and \( P = 1.01 \times 10^5 \text{ N/m}^2 \), are taken through a 3-step thermodynamic cycle. The steps are:

1. An isobaric expansion of the gas to 3 times the original volume.
2. An isochoric drop in pressure to a new pressure that is \( \frac{1}{2} \) the original pressure.
3. A compression returning the gas to its starting point. The PV plot of this compression is a straight line.

A. Draw the cycle on the empty PV plot.
B. What is the initial volume of the gas?
C. Fill in the missing items on the table below.

<table>
<thead>
<tr>
<th>Process 1</th>
<th>W</th>
<th>( \Delta U )</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process 3*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entire cycle</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* To find area of trapezoid split the area into two parts: a rectangular area and a triangular area.

D. What is the actual efficiency of this cycle?

23. At the top of the police department building in a small Missouri town sits a tornado warning siren. The siren produces a 1.20 kHz (kHz = kilohertz) tone as an isotropic, spherical sound source at a 1800 W power level. The siren is on top of a tower. Note: Threshold of hearing intensity is \( I_o = 1.0 \times 10^{-12} \text{ W/m}^2 \).

A. What is the minimum height of the tower such that at the level of the roof of the building the intensity of the sound from the siren is no more than the threshold of pain, i.e., \( I_{pain} = 1.0 \text{ W/m}^2 \)? (Note: \( A_{sphere} = 4\pi r^2 \))

B. Suppose the town policeman is driving toward the police department. At a distance of 2.82 km, what is the intensity level, in decibels, of the sound from the siren as detected in the police car.

C. Now suppose the policeman is racing toward the police department at 26.0 m/s. Assuming the 26.0 m/s is the same speed the police car is traveling toward the siren, determine the frequency of the siren sound detected by the police car. Take the speed of sound in air to be 340 m/s.

24. 4.5 moles of an ideal gas undergo a pair of processes shown on the PV plot to the right, starting at state A and ending at state C. In the table enter “0”, “+”, or “-” to indicate what happens to the quantity at the top of the column for the given process.

<table>
<thead>
<tr>
<th>Process</th>
<th>W</th>
<th>( \Delta U )</th>
<th>Q</th>
<th>( \Delta T )</th>
<th>( \Delta V )</th>
</tr>
</thead>
<tbody>
<tr>
<td>A ( \rightarrow ) B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B ( \rightarrow ) C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A ( \rightarrow ) B ( \rightarrow ) C (entire process)</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. _____ At which state, A, B, or C, is the average (root mean square) speed of an ideal gas molecule greatest?

2. _____ At which state, A, B, or C, is the temperature greatest?

Suppose a third process, an isothermal expansion, is performed to complete the cycle taking the gas from state C back to state A. In the spaces provided below, enter “0”, “+”, or “−” to indicate what happens to the named quantities for the total cycle.

\[ W_{\text{NET}} \quad \Delta U_{\text{NET}} \quad Q_{\text{NET}} \quad \Delta T \]

B. The drawing represents a continuous transverse wave traveling along the positive x direction of a string. The wave is being produced by a fixed frequency oscillator that is not shown. Find

Amplitude ________ m  Wavelength ________ m  Frequency ________ hz  Wave speed ________ m/s

Suppose that by some unknown means the tension in the string is increased. Imagine someone on the right pulling on that string with more force. Which of the above 4 quantities will clearly increase in value?

Suppose a different string with a larger linear mass density is used in place of the original string. The new string is attached to the same unpictured oscillator. Which of the four quantities above, if any, clearly increases?

25. 2.50 moles of a monatomic ideal gas, initially at STP (0°C and P = 1.01 × 10^5 N/m^2) are carried through the following cycle.

1. An isothermal expansion taking the gas to a new state with a volume 3 times the original volume.

2. An isobaric compression to a new volume of 0.108 m^3 and a new temperature of 175 K.

3. An adiabatic compression that returns the gas to its starting state.

A. What is the volume of the gas at the end of the isothermal expansion?

B. On the empty PV plot to the right, draw the plots of the 3 processes and use arrows to show the directions of each.

C. Fill in the following table. Show your work in the space below the table.

<table>
<thead>
<tr>
<th></th>
<th>W</th>
<th>\Delta U</th>
<th>Q</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isothermal Expansion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isobaric Compression</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adiabatic Compression</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete Cycle</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
D. Is this cycle behaving as a heat engine or as a refrigerator? What is the actual efficiency of this cycle?

26. A. An amplified musical instrument, behaving as an isotropic spherical emitter of sound, has an intensity level that is 25.0 dB greater than when the instrument is not amplified. The intensity of the unamplified instrument is $6.50 \times 10^{-6}$ W/m$^2$.

1. What is the intensity of the amplified musical instrument? (Note: $10^{2.5} = 316$.)

Suppose the device used to measure the intensity level is moved to a location that is 10 times farther from the musical instrument than where it was originally.

2. Will the amplified intensity at the new distance be larger or smaller than the amplified intensity at the original distance? Circle one: Larger Smaller

3. By what factor has the intensity changed? Express as a ratio.

\[
\frac{I_{\text{amplified}} \text{ (at new distance)}}{I_{\text{amplified}} \text{ (at old distance)}} = \text{___________}
\]

4. [4 pts.] What is the new dB reading of the amplified sound relative to the unamplified sound at the new distance?

B. Two underwater submersibles are approaching each other head-on. The first sub, Nemo, has a speed of 12.0 m/s and the speedier second sub, Triton, has a speed of 22.0 m/s. Nemo sends out an 1850 Hz sonar wave that travels at a speed of 1560 m/s.

1. What is the frequency of the sonar wave detected by Triton?

2. Part of the sonar wave detected by Triton is reflected by Triton back to Nemo. What frequency does Nemo detect for the returned, reflected sonar wave?