

Self- Assessment Before and After Facilitating Session.
Topic: First Law Control Mass 4-1

Facilitators's Name: _____
 Your Name: _____

Name: _____
 Self Assessment - Preparatory

Please use the following codes and please mark your selection. 1= Strongly Disagree 2=Disagree 3 = Unsure/Undecided 4=Agree 5 = Strongly Agree		Before peer teaching					After peer teaching							
		SD				SA	SD				SA			
1.	I have read the chapter before coming to the discussion session today.	1	2	3	4	5								
2.	I can read the property table for water and refrigerant-134a to determine properties of a system once I know the state of that system. Using table A-5 (saturated water-pressure table), for example, I found that water at a pressure of $P = 2$ MPa starts to boil at 212.42°C ($T_{\text{sat}@2 \text{ MPa}} = 212.42^\circ\text{C}$). The volume for the saturated liquid state is $v_f = 0.0011177 \text{ m}^3/\text{kg}$ and the volume when all the water has turned into vapor (saturated vapor phase) is $v_g = 0.09963 \text{ m}^3/\text{kg}$. Hence, if I had 1 kg of water at a temperature of 150°C , the water is in <u>compressed liquid phase</u> (since the given temperature, $T < T_{\text{sat}@2 \text{ MPa}}$) which means that its volume can be estimated to be $n = n_f@150^\circ\text{C}$ (read the temperature table A-4, $n_f@150^\circ\text{C}$) . It will start boiling if I can increase the temperature to the saturation temperature, 212.42°C . At this temperature, further addition of energy will force the water to begin vaporizing. On the contrary, if the water temperature is given as 250°C , then the water is <u>superheated vapor because its temperature is higher than the saturation temperature</u> at 2 MPa ($T > T_{\text{sat}@2 \text{ MPa}}$). If this was the case, then the other properties for water at the given T and P, can be obtained by reading table A-6 (superheated water table).	1	2	3	4	5								
3.	Using table A-4 (saturated water-temperature table), for example, I found that water at a temperature of $T = 50^\circ\text{C}$ starts to boil at 12.349 kPa ($P_{\text{sat}@50^\circ\text{C}} = 12.349 \text{ kPa}$). The volume for the saturated liquid state is $v_f = 0.001012 \text{ m}^3/\text{kg}$ and the volume when all the water has turned into vapor (saturated vapor phase) is $v_g = 12.03 \text{ m}^3/\text{kg}$. Hence, if I had 1 kg of water at a pressure of 50 kPa , the water is in <u>compressed liquid phase</u> (since the given pressure, $P > P_{\text{sat}@50^\circ\text{C}}$) which means that its volume can be estimated to be $n = n_f@50^\circ\text{C}$ (read the temperature table A-4, $n_f@50^\circ\text{C}$) . It will start boiling if I can reduce the pressure to the saturation pressure, 12.349 kPa . At this pressure, water will vaporize. Further reduction in pressure will convert the wet-mix phase to superheated vapor. On the contrary, if the water pressure is given as 5 kPa , then the water is <u>superheated vapor because its pressure is smaller than the saturation pressure</u> at 50°C ($P < P_{\text{sat}@50^\circ\text{C}}$). If this was the case, then the other properties for water at the given T and P, can be obtained by reading table A-6 (superheated water table).	1	2	3	4	5								
4.	I am aware that if I have determined the phase of a system as <u>compressed liquid</u> , than the specific properties such as v , u , and h can be approximated to be $v_{f@T}$, $u_{f@T}$, and $h_{f@T}$. Hence, I need to refer to the <u>temperature table</u> to obtain the properties of v , u , and h .	1	2	3	4	5								
5.	I realize that if I have determined that the phase of my system as <u>superheated vapor</u> , than the specific properties such as v , u and h are $v_{@T,P}$, $u_{@T,P}$, and $h_{@T,P}$. Hence, I need to refer to the <u>superheated water or superheated refrigerant 134a table</u> to obtain the properties v , u and h . If the values cannot be read from the table directly but lies between two values, then I can approximate it to be between the two values or I can perform the interpolation technique to obtain the exact value.	1	2	3	4	5								

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		1	2	3	4	5	1	2	3	4	5	
6.	I am able to define the term <i>quality</i> in the wet-mix phase as the ratio of the vapor mass to the system's total mass or mathematically represented as Quality, $x = (\text{mass of vapor} / \text{mass of system}) = \frac{m_g}{m} = \frac{m_g}{m_f + m_g}$. The more vapor in the wet mix phase, the higher the quality. The <u>highest value is one (saturated vapor)</u> if all the liquid has vaporized, hence $m_f = 0$ and $m_g = 1$, thus making $x = 1$. <u>The lowest value is zero (saturated liquid)</u> since at this state, $m_g = 0$, ($m_f = 1$) hence $x = 0$. Values of x along the saturated liquid line and saturated vapor line on the property diagrams are 0 and 1 respectively. In the wet-mix phase, $0 < x < 1$, and <u>quality is not defined in any other phases</u> .are 0 and 1 respectively. In the wet-mix phase, $0 < x < 1$, and <u>quality is not defined in any other phases</u> .	1	2	3	4	5		1	2	3	4	5
7.	I can derive the average value of y in the wet-mix phase by doing the following. Consider a tank of total volume V containing a mixture of liquid (mass is m_f) and vapor (mass is m_g) of total mass, m , I can write $V = V_f + V_g$. Replacing the total volume by the specific volume, $m n_{avg} = m_f n_f + m_g n_g$. Dividing both sides by the total mass, m , then $n_{avg} = \frac{m_f n_f + m_g n_g}{m} = \frac{m_f}{m} n_f + \frac{m_g}{m} n_g$. Realize that $m = m_f + m_g$, hence by replacing m_f by $m - m_g$, and recalling that $x = \frac{m_g}{m}$, then $n_{avg} = \left(\frac{m - m_g}{m}\right) n_f + \frac{m_g}{m} n_g = \left(\frac{m}{m} - \frac{m_g}{m}\right) n_f + x n_g$ Canceling the masses and replacing the mass ratios with the quality, then, $n_{avg} = (1 - x) n_f + x n_g = n_f - x n_f + x n_g = n_f + x(n_g - n_f) = n_f + x n_{fg}$ The expression $x n_{fg}$ is often written in place of $x(n_g - n_f)$. In the wet-mix phase, it is understood that the property y is an average value, hence $y = y_f + x(y_g - y_f) = y_f + x y_{fg}$ and this expression is ONLY VALID while the system is boiling. At the saturated liquid and saturated vapor line, $y = y_f$ and y_g respectively since $x = 0$ and $x = 1$ respectively . Note that the term y_{fg} means $y_g - y_f$.	1	2	3	4	5		1	2	3	4	5
8.	I am able to determine the phase of a system if I know the state of the system. For example if the temperature of refrigerant-134a in a tank is 0°C , and the quality of the system is 0.2000, then the <u>phase is wet-mix since the quality is $0 < x < 1$</u> . Then the system's pressure must be the saturation (boiling) pressure since the system is in a wet-mix phase (boiling). The other properties are determined by using the expression $y = y_f + x y_{fg}$. The volume, $n = n_f + x n_{fg} = 0.014552 \text{ m}^3/\text{kg}$ (use values from table A-11), will be used as one of the property to determine the final state of the system since a <u>rigid tank means no change in volume</u> (and hence the specific volume since the mass remains constant for closed systems). Thus if the system's temperature is increased to 20°C , then the phase for the final state ($T = 20^\circ\text{C}$, $n = 0.014552 \text{ m}^3/\text{kg}$) is determined by comparing $v = 0.014552 \text{ m}^3/\text{kg}$ to the saturated liquid volume, n_f , and the saturated vapor volume, n_g , at $T = 20^\circ\text{C}$. Since $n_f < n < n_g$, at $T = 20^\circ\text{C}$ (read Table A-11), then the final state is still wet-mix phase . Hence the pressure is the saturation (boiling) pressure at 20°C ($P = P_{sat@20^\circ\text{C}}$). Before other properties such as u and h can be determined using the expression $y = y_f + x y_{fg}$, the quality for this final phase must be calculated. Note that v_f and v_g which are used must be the values read at $T = 20^\circ\text{C}$. It can be shown that the	1	2	3	4	5		1	2	3	4	5

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	quality is $x = \left[\frac{n - n_f}{n_g - n_f} \right]_{@20^\circ C} = 0.3926$. It can be shown that if the initial state had a quality of 0.8, then the final state when the temperature is increased to, 20°C will be superheated vapor since $n > n_g$. Hence use table A-13 to determine u and h .										
9.	I am aware that a system's property changes due to <i>interaction energies or dynamic energies</i> that cross the imaginary boundary of the system. When a system's property has changed, we say a process has taken place. The forms of dynamic energy include <i>heat, work and energy of mass transfer</i> . Mass transfer is only involved when an open system (control volume) such as cold water entering a chamber (the system) and hot water exiting the chamber is discussed.	1	2	3	4	5	1	2	3	4	5
10.	I am able to identify <i>heat (short for heat transfer)</i> as a <u>form of thermal energy in motion due to a temperature difference</u> . In other words thermal energy that crosses a system's boundary because the temperature inside the system and the temperature of the surrounding is not the same. The name heat is only used when the thermal energy is crossing the system's boundary. If there is absolutely <u>no temperature difference or</u> when the temperature difference is very small or sometimes called <i>infinitely small, $DT = 0$</i> , between the system and the surrounding, then the system and surrounding is said to be in <i>thermal equilibrium</i> . <i>An infinitesimal heat transfer is achieved over very long time period</i> and the heat transfer process is referred to as an <i>isothermal process</i> .	1	2	3	4	5	1	2	3	4	5
11.	I realize that the term heat is usually represented by the symbol, Q, in units of kilojoule (kJ) . Q, designates the <u>total amount of heat received or lost by a system</u> . Often times, the symbol, q , is used to represent <u>specific heat or the amount of heat received or lost for each unit mass (1 kg) of the system</u> . Hence the unit for q ($q = Q/m$) is kilojoule per kilogram (kJ/kg) . For example, if 5 kg of water gains 10 kJ of heat then the specific heat is $q = 10 \text{ kJ} / 5 \text{ kg} = 2 \text{ kJ/kg}$. Note that if there is <u>no heat transfer</u> to or from a system then $q = 0 \text{ kJ/kg}$.	1	2	3	4	5	1	2	3	4	5
12.	I realize that in other cases, the symbol, \dot{Q} , is used to represent the <u>rate of heat transfer which is the amount of heat received or lost by a system for each unit time (1 second)</u> . Hence, the unit for \dot{Q} ($\dot{Q} = Q/t$) is kilojoule per second (kJ/s) or kilowatt (kW) . Note also that kilo means 1000. Hence, 1 kJ = 1000 J and 1 kW = 1 kJ/s. For example if 10 kJ of heat is gained by water over a period of 10 seconds, then the rate of heat transfer into the water is $\dot{Q} = 10 \text{ kJ} / 10 \text{ s} = 1 \text{ kJ/s} = 1 \text{ kW}$.	1	2	3	4	5	1	2	3	4	5
13.	I am aware that the usual convention used for heat transfer is positive value or usually Q_{in} for heat received or gain by a system and negative value or Q_{out} for heat lost by a system . Generally, the symbol Q represented in textbooks refers to the net (total) heat transfer $Q = Q_{net,in} = Q_{in} - Q_{out}$. As a note, heat can be transferred by either conduction (direct contact), or convection (movement) or radiation (no medium required).	1	2	3	4	5	1	2	3	4	5

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		1	2	3	4	5	1	2	3	4	5
14.	I realize that if the energy interaction is not heat, then it is either work done or mass transfer. In a closed system (control mass) where no mass enters or leaves the system, then the interaction must be heat transfer or work done or both. As a reminder, changes in a system's property such as T, P, U, V or H are usually caused by energy interactions that cross the system's boundary. Hence, Q and W are not states of a system, but rather the cause for the states of a system to change. It is ridiculous to write Q_1 or Q_2 to represent initial and final heat transfer. So, DO NOT WRITE ΔQ or ΔW . The symbol delta, D , is reserved to mean a change between final and initial values for a system's property. The expression $Du = u_2 - u_1$ represents the internal energy change in a process.										
15.	I realize that work done is usually represented by the symbol, W , in units of kilojoule (kJ). W , designates the total amount of work done by or on a system. Often times, the symbol, w , is used to represent specific work done by or on the system for each unit mass (1 kg) of the system. Hence the unit for w ($w = W/m$) is kilojoule per kilogram (kJ/kg). For example, if 10 kJ of work is done on a 5 kg system, then the specific work is $w = 10 \text{ kJ} / 5 \text{ kg} = 2 \text{ kJ/kg}$.										
16.	I realize that in other cases, the symbol, \dot{W} , is used to represent the rate of work done (power) which is the amount of work done by or on a system for each unit time (1 second). Hence, the unit for \dot{W} ($\dot{W} = W/t$) is kilojoule per second (kJ/s) or kilowatt (kW). Note also that kilo means 1000. Hence, 1 kJ = 1000 J and 1 kW = 1 kJ/s. For example if 10 kJ of work is done on a system over a period of 10 seconds, then the input power is $\dot{W} = 10 \text{ kJ} / 10 \text{ s} = 1 \text{ kJ/s} = 1 \text{ kW}$.										
17.	I realize that the convention used for work done by a system (output power) is positive or W_{out} and the work done on a system (input power) is negative or W_{in} .										
18.	I am aware that when I place an electrical resistor into water and pass a current, i , through the resistor, then electrical work, $W_{in,e}$ is done on the system. The amount of work can be determined by multiplying the voltage source, ζ , the current, i , and the amount of time or clock reading, t , that the current is allowed to pass through the resistor. Hence, the electrical work done is $W_{in,e} = \zeta it$. Generally, the symbol W represented in textbooks refers to the net work done $W = W_{net,out} = W_{out} - W_{in}$ ($\dot{W} = \dot{W}_{net,out} = \dot{W}_{out} - \dot{W}_{in}$).										
19.	I know that another common form of work done on a system, $W_{in,pw}$, is the work done by a paddle-wheel or a fan which is rotating inside a system such as a fan rotating inside a room.										
20.	I realize that another important form of work done is the mechanical work done which is due to contact forces such as pushing and pulling. Pushing an object with a force, F , and causing the object to move from position, s_1 to a final position, s_2 , which is a total distance, s , will yield a total work done of, $W = F(s_2 - s_1) = Fs$. If the force changes in strength all the time between the initial position and the final position, then the work done, dW , by each force over the distance, ds , is $dW = Fds$. Hence, the total work done to move the object from its initial position to its final position										

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	must be the sum of all the incremental work done, $W = \sum_{k=1}^{k=n} dW = dW_1 + dW_2 + \dots + dW_n$. For infinitesimally small (very small) ds , the total work done is, $W = \int_1^2 dW = \int_1^2 Fds$. If the force is constant (both the strength and direction) from the initial to the final position , then $W = \int_1^2 Fds = F \int_1^2 ds = F(s_2 - s_1) = Fs$, which is the same as the one obtained before.											
21.	I realize that the mechanical work done is important in thermodynamics since there is always expansion (W_{out}) and compression (W_{in}) of systems contained in a piston-cylinder device. When a system expands due to heat that it received, a force, F , pushes up on the surface of the piston of area, A , and causing the piston to rise, hence the word expand. Since the force exerted on the piston is related to pressure, P , defined as, $Pressure = \frac{Force}{Area} = \frac{F}{A}$, hence $F = PA$. Then the work done to push the piston a distance, ds , is $dW = Fds = PAds$. Notice that the product, Ads , is just the volume change , $dV = Ads$. Hence the total work done by the system in changing the position of the piston from state 1 to state 2 during the expansion must be $W = \int_1^2 dW = \int_1^2 Fds = \int_1^2 PdV$. The specific work done is easily obtained by dividing both sides by the mass, m , which then yields $w = \int_1^2 dw = \int_1^2 Pd\mathbf{n}$. Notice that in the case where the pressure is constant throughout the expansion process, then $w = P \int_1^2 d\mathbf{n} = P(\mathbf{n}_2 - \mathbf{n}_1)$ or for the total work done, $W = P \int_1^2 dV = P(V_2 - V_1)$. A sketch of a P - v graph will reveal that, $P(\mathbf{n}_2 - \mathbf{n}_1)$, is the area under the graph and hence the specific work done . In cases where the pressure is changing during the expansion (such as an isothermal process), the specific form of the pressure as a function of the volume is necessary before the integration can be solved. Note that this type of work where it involves movement of a system's boundary (piston-cylinder device) is called the boundary work done, W_b .	1	2	3	4	5		1	2	3	4	5
22.	I realize that an isothermal process is a process where the temperature of the system remains the same throughout the expansion or compression process ($T_1 = T_2$). In this case, $PV = constant = k$. Hence the pressure is inversely proportional to the volume, $Pressure = \frac{constant}{volume} = \frac{k}{V}$. The boundary work done in this case is then,	1	2	3	4	5		1	2	3	4	5

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$W_b = \int_1^2 dW = \int_1^2 Fds = \int_1^2 PdV = \int_1^2 \frac{k}{V} dV = k \int_1^2 \frac{1}{V} dV = k(\ln V_2 - \ln V_1) = k \ln \left(\frac{V_2}{V_1} \right)$. The fact that $PV = constant$ means that $P_1V_1 = P_2V_2 = P_3V_3 = k$. Hence, the boundary work done can also be written as $W_b = k \ln \left(\frac{V_2}{V_1} \right) = P_1V_1 \ln \left(\frac{V_2}{V_1} \right) = P_1V_1 \ln \left(\frac{P_1}{P_2} \right)$. At this juncture, I must make sure that I am able to obtain the last expression by deriving it using the first principle which is $W_b = \int_1^2 dW = \int_1^2 Fds = \int_1^2 PdV$ and the knowledge of $PV = constant$. In cases where the system contains real gases such as air which can be treated as an ideal gas, then the equation of state, $PV = NR_uT$, or $PV = mRT$ can be used. Then, the constant, k , can be replaced by mR or NR_u .											
23.	I realize that the first law of thermodynamics states that energy is always conserved in any processes. In other words, total energy entering or leaving a system must be the same as the total energy change of the system. For example, if the amount of energy received by 1 kg of compressed liquid water at room temperature and pressure is 100 kJ, then the total energy of the water must increase by 100 kJ. On the other hand, if the system loses energy by 100 kJ, then the system's total energy must drop by 100 kJ also.	1	2	3	4	5					
24.	I can write the <u>energy balance</u> for the first law as $\frac{\text{Energy gain by a system}}{\text{by a system}} - \frac{\text{Energy lost by a system}}{\text{by a system}} = \frac{\text{Total energy change within the system}}{\text{within the system}}$. Mathematically, I can represent it by writing, $E_{in} - E_{out} = DE_{sys}$, in units of kilojoule OR $\dot{E}_{in} - \dot{E}_{out} = \Delta \dot{E}_{sys}$ in units of kilowatt or alternatively, $e_{in} - e_{out} = De_{sys}$ in units of kilojoule per kilogram. Note that the <u>energy change within the system</u> , means the <u>difference between the system's initial energy and final energy</u> , $DE_{sys} = E_{final} - E_{initial} = E_2 - E_1$.	1	2	3	4	5					
25.	I can identify the mechanism for energy transfer as the interaction or dynamic energies (energies crossing the boundaries of a system) which are heat, Q, work done, W, and the energy of mass transfer for an open (control volume) system, E_{mass} .	1	2	3	4	5					
26.	I can rewrite the energy gain by the system by replacing it with the interaction energies, $\frac{\text{Energy gain by a system}}{\text{by a system}}$ or E_{in} is the sum of the heat received, Q_{in} , the work done on the system, W_{in} , and the energy of the mass flowing into the system, $E_{mass,in}$. On the other hand, the energy lost by the system can be written the same way, $\frac{\text{Energy lost by a system}}{\text{by a system}}$ or E_{out} is the sum of the heat lost, Q_{out} , the work done by the system, W_{out} , and the energy of the mass flowing leaving the system, $E_{mass,out}$. Mathematically, the expression is, $E_{in} = Q_{in} + W_{in} + E_{mass,in}$ and $E_{out} = Q_{out} + W_{out} + E_{mass,out}$. Notice that the energy interactions Q, W and E_{mass} are the <u>cause for the energy change</u> within a system. If there aren't any energy	1	2	3	4	5					

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		1	2	3	4	5	1	2	3	4	5
	crossing into and out of a system's boundary that is, $E_{in} = E_{out} = 0$, then the system's total energy remains unchanged, $DE_{sys} = 0$ and hence $E_2 = E_1$.										
27.	I am very familiar with the symbols $\dot{Q} = \frac{Q}{t}$, $\dot{W} = \frac{W}{t}$, $\dot{E}_{sys} = \frac{\Delta E_{sys}}{t}$, (kW); $w = \frac{W}{m}$, $q = \frac{Q}{m}$, $e = \frac{E}{m}$ ($\frac{kJ}{kg}$).	1	2	3	4	5	1	2	3	4	5
28.	I am aware that the energies of a system is the sum of its thermal energy associated with its temperature, $U = mcT$, (where c is the system's specific heat) its kinetic energy associated with its speed, $KE = \frac{m\vec{n}^2}{2000}$ and its potential energy associated with its vertical position, $PE = \frac{mgy}{1000}$. Hence the energy change within the system is $\Delta E_{sys} = (U_2 - U_1) + (KE_2 - KE_1) + (PE_2 - PE_1) = \Delta U + \Delta KE + \Delta PE$. Note that $\Delta U = mc\Delta T$, $\Delta KE = \frac{m(\vec{n}_2^2 - \vec{n}_1^2)}{2000}$ and $DPE = \frac{mg(y_2 - y_1)}{1000} = \frac{mgh}{1000}$. Note that in most cases the specific internal energy, u, can be obtained by reading the property table and that the expression $u = c\Delta T$ is <u>only valid while a system is experiencing temperature change</u> within a phase such as in the compressed liquid or superheated vapor phases.	1	2	3	4	5	1	2	3	4	5
29.	I realize that I can write all the expressions for the first law in units of kilojoule, kilowatts or kilojoule per kilogram. Hence the energy balance can be expressed in the following ways: $\frac{\text{Energy gain by a system} - \text{Energy lost by a system}}{\text{within the system}} = \text{Total energy change}$. Or mathematically, $E_{in} - E_{out} = \Delta E_{sys}$ in kJ, or $\dot{E}_{in} - \dot{E}_{out} = \Delta \dot{E}_{sys}$, in kW, or $e_{in} - e_{out} = \Delta e_{sys}$ in kJ/kg. Alternatively, it can written as $(Q_{in} - Q_{out}) + (W_{in} - W_{out}) + (E_{mass,in} - E_{mass,out}) = \Delta U + \Delta KE + \Delta PE$ in kJ or $\left(\dot{Q}_{in} - \dot{Q}_{out} \right) + \left(\dot{W}_{in} - \dot{W}_{out} \right) + \left(\dot{E}_{mass,in} - \dot{E}_{mass,out} \right) = \Delta \dot{U} + \Delta \dot{KE} + \Delta \dot{PE}$ in kW or $(q_{in} - q_{out}) + (w_{in} - w_{out}) + (J_{mass,in} - J_{mass,out}) = \Delta u + \Delta ke + \Delta pe$, in kJ/kg.	1	2	3	4	5	1	2	3	4	5
30.	I am aware that a <u>stationary system</u> means: $DKE = 0$ and $DPE = 0$. So, $DE_{sys} = DU$ in kJ, $\Delta \dot{E}_{sys} = \Delta \dot{U}$ in kW and $De_{sys} = Du$ in kJ/kg.	1	2	3	4	5	1	2	3	4	5

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		1	2	3	4	5	1	2	3	4	5
31.	I know that a <u>closed system</u> means $E_{mass,in} = 0$ and $E_{mass,out} = 0$ or $\dot{E}_{mass,in} = \dot{E}_{mass,out} = 0$ or $J_{mass,in} = J_{mass,out} = 0$.										
32.	Hence, for a <u>stationary closed system</u> , the first law of thermodynamics energy balance can be written in any of the following ways: $(Q_{in} - Q_{out}) + (W_{in} - W_{out}) = \Delta U$ or $(\dot{Q}_{in} - \dot{Q}_{out}) + (\dot{W}_{in} - \dot{W}_{out}) = \Delta \dot{U}$ or $(q_{in} - q_{out}) + (w_{in} - w_{out}) = \Delta u$. Care must be taken in using the symbol Δ (pronounced as delta), to mean the change between the final value and the initial values within the system. Hence, we DO NOT WRITE $DQ = Q_{in} - Q_{out}$. This is because Q, or W are energy interactions (CAUSES OF CHANGE) and do not have any values at the initial or final state. ONLY PROPERTIES SUCH AS E, U, H, KE, PE, AND T HAVE INITIAL AND FINAL VALUES DURING A PROCESS (CHANGE OF STATE).										
33.	I know that for closed system undergoing an isochoric (constant volume) process, the boundary work done, $W_b = 0$, & since the total work done is $(W_{in} - W_{out}) = W_{others} + W_b$, hence $(Q_{in} - Q_{out}) + W_{in} = \Delta U$. Note that $W_{others} = W_{in} = W_{pw} + W_e$ where W_{pw} is the work done by a paddle-wheel (like a fan) and W_e is the electrical work done by a resistor or a heating element. Note also that the electrical work done is the product of the current through the resistor, i , the potential difference across the resistor, V , and the amount of time the current is allowed to pass, t . Hence the electrical work done by a resistor is $W_e = Vi t/1000$ in kW. Another important fact to realize is that W_{out} is W_b for an expansion process in a piston-cylinder device.										
34.	I realize that for closed system undergoing an isobaric (constant pressure) process, the volume will change and hence I need to consider the boundary work done by the system. Recall that the boundary work done is obtained by summing over the infinitesimal work done to move a piston from its initial to its final position. Mathematically, the boundary work done is, $W_b = \int P dV = P \int dV = P(V_2 - V_1) = P_2 V_2 - P_1 V_1$ where the constant pressure $P = P_1 = P_2$. Again, since the total work done, for an expansion process is, $(W_{in} - W_{out}) = W_e + W_{pw} - W_b$, hence the energy balance can be written as $(Q_{in} - Q_{out}) + W_e + W_{pw} = W_b + \Delta U = P_2 V_2 - P_1 V_1 + U_2 - U_1 = (U_2 + P_2 V_2) - (U_1 + P_1 V_1)$. Recall that in chapter 2 we had define the enthalpy of a system as $H = U + PV$. Hence, we can write $(Q_{in} - Q_{out}) + W_e + W_{pw} = (U_2 + P_2 V_2) - (U_1 + P_1 V_1) = H_2 - H_1 = m(h_2 - h_1)$. Writing the energies in terms of the enthalpies of the system is economical since values for the enthalpy can be found in property tables and I have reduced my working time to analyze the energy balance by a significant amount. So, in units of kilojoule per kilogram, the energy balance for a <u>stationary-closed system undergoing an isobaric process</u> is $(q_{in} - q_{out}) + w_e + w_{pw} = h_2 - h_1$. CAUTION: This expression is ONLY VALID for isobaric ($P_2 = P_1$) processes. At times, the expression w_{others} is encountered in the textbook in place of $w_e + w_{pw}$										

Self- Assessment Before and After Facilitating Session.

Topic: First Law Control Mass 4-1

Facilitators's Name: _____

Your Name: _____

Please use the following codes and please mark your selection. 1=- Strongly Disagree: 2=Disagree 3 = Unsure/Undecided 4=Agree 5 = Strongly Agree		Before peer teaching					After peer teaching								
		1	2	3	4	5	1	2	3	4	5				
35.	I know that for a stationary-closed system undergoing a cyclic (starts and end at the same state) process, the total energy for the final and initial states are the same, hence $DE_{sys} = DU = 0$. Due to this, the energy balance can be written as $(Q_{in} - Q_{out}) + (W_{in} - W_{out}) = 0$. This means that $Q_{in} - Q_{out} = W_{out} - W_{in}$. The physical interpretation of this is very significant since many engineering devices operate in a cycle. This expression clearly indicates that if the left side of the expression is positive then the right side must also be positive and vice-versa. In other words, for a system such as water in as a turbine to produce work and hence electricity, a <u>net amount of heat must be transferred to the system</u> . On the other hand, in order to have a net amount of heat transferred out of a system such as an air conditioner, a <u>net amount of work must be done on the system</u> .														
36.	I am aware that for a stationary-closed system undergoing an adiabatic (no heat transfer, $Q = 0$) process, the energy balance can be written as $W_{in} - W_{out} = \Delta U$. Hence, for a system in a piston-cylinder-device to <u>expand</u> (spontaneous expansion) which means that <u>work is done by the system</u> ($W_{in} = 0$), <i>DU must be negative</i> . In other words, <i>expansion will make the thermal energy of the system to drop</i> since the energy had to be used to do work in the expansion process. As a result, a <u>drop in temperature will be recorded</u> . On the other hand, if the piston is pushed down ($W_{out} = 0$), work is being done <u>on the system</u> resulting in an <i>increase in the system's thermal energy</i> . As a result, an <u>increase in temperature will be observed</u> .														
37.	I realize that if the system involves gases such as air or nitrogen, I need a way to determine the change in internal energy Du and enthalpy Dh respectively, since tables providing values for these are very limited. Hence I need to know about the energy storage ability for each gas. I am also aware that the internal energy for gases has been experimentally demonstrated to depend only on the temperature, $u = u(T)$. In other words, the internal energy at any state is specified when the temperature is known and will only change when there is a physical temperature change.														
38.	I can define <i>specific heat as the amount of heat required to change the temperature of a unit mass of any substance by 1°C or 1K</i> . The higher the specific heat, the more heat is required to change its temperature by one degree. Using the first law for a stationary closed system I can define the specific heat at constant volume to be $C_n = \left(\frac{\partial u}{\partial T}\right)_n$ and the specific heat at constant pressure to be $C_p = \left(\frac{\partial h}{\partial T}\right)_p$. Using the definition of enthalpy ($h = u + Pn$) and equation of state for ideal gases ($Pn = RT$), I am able to show that the enthalpy for gases depend only on the gas's temperature, just like the internal energy. Since both the internal energy and the enthalpy depends only on temperature, then the differential form of the energies are $du = C_n(T)dT$ and $dh = C_p(T)dT$. The energy change in a process is obtained by integrating the functions above and will yield $Du = \int_1^2 C_n(T)dT$ and $Dh = \int_1^2 C_p(T)dT$ respectively. The specific heat														

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	is a function of temperature over large temperature variations but not when the temperature variation in a process is only a few hundred. Hence obtaining the internal and enthalpy change for ideal gases can be obtained by estimation methods and some available table for C_n and C_p for certain gases. Hence, $Du \cong C_{n,avg}DT$ and the enthalpy change is $Dh \cong C_{p,avg}DT$. The average specific heat can be estimated by taking its value at the average temperature between the initial and final temperature ($C_{n,avg} = C_n$ read at $\frac{T_2 + T_1}{2}$ from the property table such as table A-2(b)).										
39.	I am able to show that by differentiating the enthalpy function, $h = u + Pn$, I can relate the specific heats $C_p = C_n + R$ in units of $kJ/kg \cdot K$. In addition, another ideal-gas property is commonly cited in the literature is the <u>specific heat ratio</u> , $k = \frac{C_p}{C_n}$. For mono-atomic gases such as helium, its value is 1.667 and is constant for any temperature. For diatomic gases such as carbon dioxide, $k = 1.4$ at room temperature.	1	2	3	4	5	1	2	3	4	5
40.	I am aware that for incompressible substances such as solids and liquids, the specific heat is just $C = C_p = C_n$ for small temperature intervals (a few hundred degrees). Then the internal energy change can be approximated to be $Du \cong C_{avg}DT = C_{avg}(T_2 - T_1)$. I realize that the volume change in solids and liquids is negligible. Hence the estimation for Du and Dh can be made by again differentiating the enthalpy, $h = u + Pn$ which yields the term $Dh = Du + nDP + PDn$. For solids, the term nDP and PDn (zero for constant volume) is not significant and hence $Dh = Du \cong C_{avg}DT$. For liquids undergoing constant pressure process, $Dh = Du \cong C_{avg}DT$ and for liquids undergoing constant temperature process, $Dh = nDP$.	1	2	3	4	5	1	2	3	4	5