Chapter 11
Heat and Thermodynamics

Homework # 85

Specific Heats at 20°C and 1 atm (Constant Pressure)

Substance	Specific Heat, *c* kcal/kg•C°	Specific Heat, *c* J/kg•C°	Substance	Specific Heat, *c* kcal/kg•C°	Specific Heat, *c* J/kg•C°
Solids			*Liquids*		
Aluminum	0.22	900	Ethyl Alcohol	0.59	2460
Brass	0.090	377	Mercury	0.033	139
Copper	0.092	387	Human body (average)	0.83	3470
Diamond	0.12	502	Protein	0.4	1700
Glass (typical)	0.20	837	Water		
Gold	0.031	129	Ice (-5°C)	0.50	2093
Iron and Steel	0.108	452	Liquid (15°C)	1.00	4186
Lead	0.031	128	Steam (110°C)	0.48	2010
Marble	0.205	858	*Gases*		
Silver	0.056	233	Air (Dry)	0.24	1005
Wood	0.4	1674	Oxygen	0.22	920

Latent Heats (at 1 atm)

Substance	Melting Point (°C)	Heat of Fusion kcal/kg	Heat of Fusion J/kg	Boiling Point (°C)	Heat of Vaporization kcal/kg	Heat of Vaporization J/kg
Oxygen	-218.8	3.3	0.14×10^5	-183	51	2.1×10^5
Ethyl Alcohol	-114	25	1.04×10^5	78	204	8.5×10^5
Water	0	79.7	3.33×10^5	100	539	22.6×10^5
Lead	327	5.9	0.25×10^5	1750	208	8.7×10^5
Silver	961	21	0.88×10^5	2193	558	23×10^5
Tungsten	3410	44	1.84×10^5	5900	1150	48×10^5

Thermal Conductivities

Substance	Thermal Conductivity, *k* kcal/s•m•C°	Thermal Conductivity, *k* J/s•m•C°
Silver	10×10^{-2}	420
Copper	9.2×10^{-2}	380
Aluminum	5.0×10^{-2}	200
Steel	1.1×10^{-2}	40
Glass (typical)	2.0×10^{-4}	0.84
Concrete/Brick	2.0×10^{-4}	0.84
Water	1.4×10^{-4}	0.56
Human Tissue (excluding blood)	0.5×10^{-4}	0.2
Asbestos	0.4×10^{-4}	0.16
Wood	$0.2\text{-}0.4 \times 10^{-4}$	0.08-0.16
Cork and Glass Wool	0.1×10^{-4}	0.042
Down	0.06×10^{-4}	0.025
Air	0.055×10^{-4}	0.023

Chapter 11
Heat and Thermodynamics
11.1 Heat, Specific Heat, and Calorimetry Problems   Homework # 86

Refer to the table of "Density of Substances" on Homework #75 in "Chapter 10-Fluids and Kinetic Theory". Refer to the table of "Specific Heats at 20°C and 1 atm (Constant Pressure)" on Homework #85 in this chapter.

I

01. How much heat is required to raise the temperature of 3.50 L of water from 15.0°C to 87.5°C?

02. A paddle wheel, placed in a 2.00 L of water, is used to convert mechanical energy to thermal energy via the friction between the paddles and the water as in one of Joule's experiments. If 14,500 J of work by the paddle wheel are converted to thermal energy of the water, what will be the temperature of the water if it started at 17.5°C?

03. A person eats a candy bar with 450 Cal. How much work must this person do to "burn" this intake of calories?

04. A 9.36-kg sample of an unknown metal requires 127 kJ of heat to raise the temperature from 22.7°C to 57.6°C.
 a.) What is the specific heat of this metal? b.) What might this metal be?

05. The radiator of an automobile holds 15.5 L of water. How much heat does it absorb if its temperature rises from 25.0°C to 79.0°C?

II

06. What is the water equivalent of 983 g of aluminum? (Water equivalent refers to the mass of water that would have the same temperature change when an equal amount of heat is absorbed as the mass of the substance in question).

07. From what minimum height would water fall to undergo a 1.00 C° change in temperature when it hit the ground?

08. Water leaves the top of Niagara Falls at a speed of 4.25 m/s and falls 53.68 m to the bottom (water actually falls 21.35 m before hitting rocks, then traveling the remainder of the 53.68 m to the Niagara river at the bottom). Assuming all of the mechanical energy of the water is converted to heat at the bottom, what will be the maximum increase in temperature of the water at the bottom?

09. The head of a hammer has a mass of 725 g and achieves a speed of 7.35 m/s just before striking a 12.6 g iron nail. If the hammer makes 8 identical blows to the nail in rapid succession, by how much will the temperature of the nail increase? Assume all of the mechanical energy of the hammer is absorbed as thermal energy by the nail.

10. A 32.5-g glass thermometer reads 19.5°C when it is placed in 235 mL of water. When thermal equilibrium between the water and the thermometer is achieved, the thermometer reads 51.3°C. What was the original temperature of the water? Assume no lose of heat to the environment.

11. A 194.7-g iron ingot at 236.7°C is placed in a 112-g aluminum calorimetry cup containing 325 mL of ethyl alcohol at 14.6°C. What will be the final temperature of the alcohol when thermal equilibrium?

12. A 265.0-g block of copper at 195.1°C is placed in a 140-g aluminum calorimetry cup containing 275 g of glycerin at an initial temperature of 12.4°C. If the final temperature is 36.8°C, what is the specific heat of glycerin?

13. How long will it take a 750-W coffee pot made of 450 g of aluminum to bring 811 mL of water at 11.1 °C to boil?

ANSWERS: **01.** 1.06×10^6 J **02.** 19.2°C **03.** 1.88×10^6 J **04.** a.) 390 J/kg•C° b.) copper **05.** 3.50×10^6 J **06.** 211 g **07.** 427 m **08.** 0.13°C **09.** 27.6°C **10.** 52.2°C **11.** 38.4°C **12.** 0.463 kcal/kg•C° (≈ 1960 J) **13.** 450 s (7.50 min)

Chapter 11
Heat and Thermodynamics

11.2 Latent Heat — Homework # 87

Refer to the tables of "Latent Heats (at 1 atm)" and "Specific Heats at 20 °C and 1 atm (Constant Pressure)" on Homework #85 in this chapter.

I

01. A sample of lead has a mass of 28.50 kg and a temperature of 23.5 °C. How much heat is needed to melt this sample?

02. If a person gives off 225 kcal of heat by the evaporation of sweat (water) from the skin during 45 minutes of exercise, how much water has been lost?

03. A sample of liquid oxygen at -183 °C (its boiling point) is in an open container. How much energy is lost by this sample if 638 g of oxygen evaporate?

II

04. An iron boiler of mass 245 kg contains 925 L of water at 21.7 °C. If a heater supplies energy at the rate of 54,000 kJ/h, How long will it take for the water __________?
    a.) to reach the boiling point
    b.) to change completely to steam

05. An experiment is performed to determine the latent heat of fusion of mercury. In the temperature range of this experiment, the specific heat of mercury is found to be 138 J/kg•C°. A 750-g sample of solid Hg at its melting point of -39.0 °C is placed in a 570-g aluminum calorimeter containing 300 mL of water at 13.25 °C. The equilibrium temperature is determined to be 5.87 °C.
    a.) What is the latent heat of fusion of mercury?
    b.) If the experimenter used the value for the specific heat of mercury that is listed in the table at the start of this chapter (Homework #84), would the experimental result for the latent heat of fusion mercury be higher or lower than that determined in part a.)? Note: It is not necessary to recalculate this latent heat, simply make an educated estimate.

06. A 67.2-kg ice skater moving at 6.45 m/s glides to a stop. Assuming the ice is at 0 °C and that 50 percent of the heat generated by friction is absorbed by the ice, how much ice melts?

III

07. What will be the final result when equal amounts of ice at 0 °C and steam 100 °C are mixed together?

ANSWERS: **01.** 1.84×10^6 J **02.** 417 g **03.** 1.34×10^5 J **04.** a.) 5.77 h b.) 44.5 h
05. a.) 1.13×10^4 J b.) slightly smaller (1.12×10^4 J) **06.** 2.10 g **07.** 33.3% steam, 66.7% water

Chapter 11
Heat and Thermodynamics
11.3 Heat Transfer: Conduction, Convection, and Radiation — Homework # 88

Refer to the table of "Thermal Conductivities" on Homework #85 in this chapter.

I

01. The windows in a house can be a major source of heat loss from the house. Because air is such a poor insulator, the layers of air on both the inner and outer surfaces of the window are at nearly the same temperature on a relatively calm day since the heat does not travel well to other parts of the room (on the inside) or away from the window (on the outside). On a windy day, this phenomenon does not occur as the outside layer is constantly replaced with fresh cool air. Calculate the rate of heat loss through a window 1.37 m x 0.76 m in area and 2.95 mm thick if the temperature at the inner surface is 16.5 °C and the temperature on the outer surface is __________.
    a.) 15.4 °C   b.) -3.6 °C on a cold windy day

02. A tungsten sphere with a radius of 25.0 cm is at the room temperature of 23.6 °C. Tungsten has an emissivity of 0.35. The walls of the room are at a temperature of -4.2 °C.
    a.) How much power is radiated by the sphere to the room?
    b.) What is the **NET** flow rate of energy from the sphere?

03. On a sunny day in the spring, the sun' rays make a 25° angle to the vertical. Approximately how much radiation does a person (e = 0.80) with a total surface area of 1.56 m^2 absorb each hour if he lies flat on his back?

04. In the human body, heat flows from the blood capillaries beneath the skin to the skin surface. On a normal day, an average of 200 W is transferred through the entire body's skin surface which has an area of 1.56 m^2. If the temperature difference between the blood capillaries and the skin surface is 0.525 °C, what is the thickness of the human tissue over which the heat must flow to reach the skin surface?

II

05. A 100-W light bulb generates 95 W of heat, which is dissipated through a glass bulb (approximating a spherical shape) with a radius of 3.00 cm and a thickness of 1.00 mm. What is the difference in temperature between the inner and outer surfaces?

06. A ceramic teapot (e = 0.70) and a shiny one (e = 0.10) each are filled to the brim with 750 mL of tea at 95.0 °C. The room in which the teapots sit is at 22.0 °C. Assume the teapots are nearly spherical in shape.
    a.) What is the rate of heat loss due to radiation from the ceramic teapot?
    b.) What is the rate of heat loss due to radiation from the shiny teapot?

For parts c.) and d.) below, assume the heat lost by radiation from each teapot is replaced by heat taken from the water in the pot, and that this heat is replaced at the same rate at which it is radiated. Further, assume the temperature (and, therefore, the rate of heat lost due to radation) of each teapot is constant. These assumptions are not a physical reality, but are made for purely pedagogical reasons.

    c.) Estimate the temperature drop of the water in the ceramic teapot after 45 minutes.
    d.) Estimate the temperature drop of the water in the ceramic teapot after 45 minutes.

ANSWERS: **01.** a.) 326 J/s (0.0776 kcal/s) b.) 5959 J/s (1.42 kcal/s) **02.** a.) 121 W b.) 39.3 W
03. 2.04 x 10^6 J **04.** 0.819 mm **05.** 10.0 °C **06.** a.) 17.06 J/s b.) 2.44 J/s c.) 14.7°C d.) 2.10°C

Chapter 11
Heat and Thermodynamics
11.4 The First Law of Thermodynamics — Homework # 89

I

01. One liter of air is cooled at a constant pressure (isobarically) until its volume is half of its original. Next, it is allowed to isothermally expand back to its original volume. Sketch the *PV* diagram for this process.

02. One liter of an ideal gas is cooled at a constant volume until it is at half its original pressure. This gas is then compressed at constant temperature back to its original pressure. Sketch the *PV* diagram for this process.

03. An ideal gas is slowly compressed isothermally to half its original volume as 240 kcal of heat are removed.
 a.) What is the change in internal energy of the gas? b.) How much work was done during this process?

II

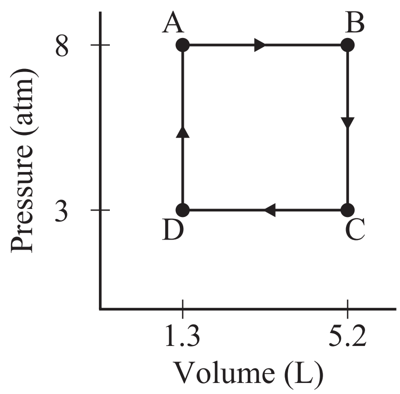
04. The latent heat of vaporization for water is 539 kcal/kg at 100 °C. One kilogram of steam occupies 1.67 m^3 at 100 °C and 1 atm.
 a.) How much work is done in converting 1.00 kg of water to steam at 100 °C and 1 atm?
 b.) What is the change in internal energy when 1.00 kg of water is converted to steam at 100 °C and 1 atm?
 c.) Use the ideal gas law to calculate the volume of 1.00 kg of steam at 100 °C and 1 atm.
 d.) Why is the actual volume smaller than that predicted by the ideal gas law?

05. An ideal gas is allowed to expand adiabatically to twice its volume as it does 2340 J of work.
 a.) How much heat is added to the system? b.) What is the change in internal energy of the system?
 c.) Did the temperature increase or decrease during this process?

06. A 290 mL ideal gas sample at 7.25 atm isobarically expands to 715 mL. The volume is then held constant as heat is slowly removed, reducing the pressure, until the temperature reaches its original value.
 a.) What is the total work done by the gas? b.) What is the total heat flow into the gas?

07. The graph at the right shows a cycle for 0.175 moles of an ideal gas. This gas has molar heat capacity values of C_P = 19.10 J/K•mol and C_V = 10.78 J/K•mol.
 a.) Calculate the temperature at points A, B, C, and D.
 b.) Determine the change in temperature in stages AB, BC, CD, and DA.
 c.) Determine the heat flow into the gas in stages AB, BC, CD, and DA.
 d.) Determine the work done in stages AB, BC, CD, and DA.
 e.) Determine the change in internal energy in stages AB, BC, CD, and DA.
 f.) What is the **NET** heat flow in one cycle?
 g.) What is the **NET** work done in one cycle?
 h.) What is the **NET** change in internal energy in one cycle?

Problem 07



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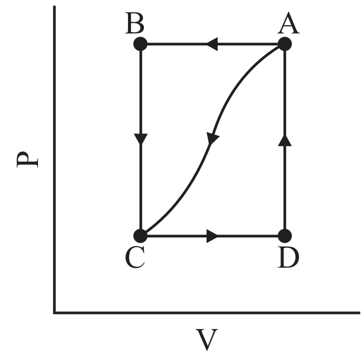
ANSWERS: **03.** a.) 0 kcal b.) 240 kcal **04.** a.) -1.69 x 10^5 J b.) 2.08 x 10^6 J c.) 1.70 m^3
04. d.) intermolecular attractions **05.** 0J b.) -2340 J c.) Decrease **06.** a.) -312 J b.) 312 J
07. a.) T_A = 724 K, T_B = 2896 K, T_C = 1086 K, T_D = 271.5 K
07. b.) ΔT_{AB} = 2172 K, ΔT_{BC} = -1810 K, ΔT_{CD} = -814.5 K, ΔT_{DA} = 452.5 K
07. c.) Q_{AB} = 7260 J, Q_{BC} = -3415 J, Q_{CD} = -2722 J, Q_{DA} = 854 J
07. d.) W_{AB} = -3161 J, W_{BC} = 0 J, W_{CD} = 1185 J, W_{DA} = 0 J
07. e.) ΔU_{AB} = 4099 J, ΔU_{BC} = -3415 J, ΔU_{CD} = -1537 J, ΔU_{DA} = 854 J
07. f.) Q_{ABCDA} = 1977 J g.) W_{ABCDA} = -1976 J h.) ΔU_{ABCDA} = 0 J (actual = 1 J due to rounding)

11.4 The First Law of Thermodynamics — Homework # 90

II



Problems 08 and 09

08. The graph at the right shows possible pathways for an ideal gas. For pathway AC, 120 J of heat leave the system and 65 J of work are done on the system. When the gas is taken along pathway CDA, the work done by the gas is W_{CDA} = -42 J. Assume $P_A = 2.5\ P_D$.
   a.) Determine the change in internal energy along pathway A to C.
   b.) Determine the heat added to the gas in process CDA.
   c.) How much work is done in process ABC?
   d.) What is Q for path ABC?
   e.) Determine Q for path BC if ΔU_{BA} = 25 J.

09. The graph at the top-right shows possible pathways for an ideal gas. For pathway AC, 72 J of heat leave the system and 47 J of work are done on the system. When the gas is taken along pathway ABC, the work done by the gas is W_{ABC} = 34 J. Assume $P_C = ½\ P_B$. (Note: The graph is not drawn to scale to reflect this relationship between P_C and P_B for problem 09-it is drawn accurately for problem 08.)
   a.) What is ΔU_{AC}?
   b.) Determine the heat flow along pathway ABC.
   c.) Determine the work done by/on the gas in process CDA.
   d.) How much heat flows in process CDA?
   e.) Determine Q for path DA if ΔU_{CD} = 14 J.

ANSWERS: **08.** a.) -55 J b.) 97 J c.) 105 J d.) -160 J e.) Q_{BC} = -30 J
09. a.) -25 J b.) -59 J c.) -17 J d.) 42 J e.) 11 J

Chapter 11
Heat and Thermodynamics

11.5 The Second Law of Thermodynamics-Heat Engines/Refrigeration   Homework # 91

I

01. An engine, whose operating temperatures are 685°C and 365°C, produces 7650 J of heat while performing 2650 J of useful work.
    a.) What is the actual thermal efficiency of this engine?
    b.) What is the Carnot efficiency?
    c.) What is the second-law efficiency?

02. An engine has a Carnot efficiency of 35.0%. What is the operating temperature of this engine if the exhaust is measured to have a temperature of 335°C?

03. What is the maximum efficiency of a heat engine whose operating temperatures are 480°C and 295°C?

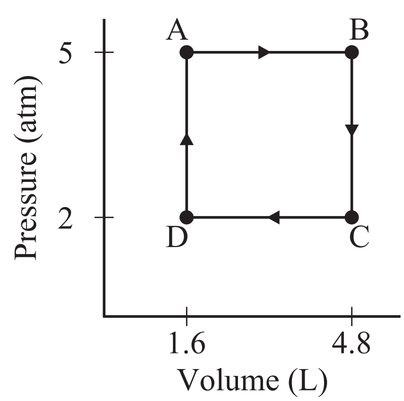
II

04. A heat engine that operates at a second-law efficiency of 60% operates between a temperature range of 680°C and 355°C while producing work at the rate of 2250 kW. How much heat is produced in a 40.0 minute period?

05. A Carnot engine performs work at the rate of 470 kW while absorbing 955 kcal of heat per second. If the temperature of the heat source is 660°C at what temperature is the waste heat exhausted?

06. The graph at the right shows a cycle for a simple heat engine that contains 0.1088 moles of an ideal gas. This gas has molar heat capacity values that have been determined to be C_P = 20.14 J/K•mol and C_V = 11.82 J/K•mol.
    a.) Determine the heat flow into the gas in stages AB, BC, CD, and DA.
    b.) What is the heat flow in during process DAB?
    c.) What is the heat flow in during process BCD?
    d.) Determine the work done in stages AB, BC, CD, and DA.
    e.) What is the **NET** work done in one cycle?
    f.) What is the thermal efficiency of this engine?
    g.) What is the **NET** heat flow in one cycle?
    h.) Determine the change in internal energy in stages AB, BC, CD, and DA.
    i.) What is the **NET** change in internal energy in one cycle?

Problem 06



07. A refrigerator, rated at 260 W, removes 1950 kJ of heat in 25.0 minutes. What is the COP for this refrigerator?

III

08. Steam engines work in pairs at a steam power plant such that the heat output of the first steam engine is the approximate heat source for the second steam engine. One steam power plant that produces 875 MW of power has operating temperatures of 740°C and 465°C in the first steam engine, and 455°C and 315°C in the second. Assume the efficiency of the engines is 65.0% of the ideal (Carnot) engine.
    a.) At what rate must heat be provided to this system?
    b.) If coal has a heat of combustion of 2.8×10^7 J/kg, at what rate must coal be burned to supply this system?

ANSWERS: **01.** a.) 25.7% b.) 33.4% c.) 77.0% **02.** 662°C **03.** 24.6% **04.** 2.10×10^{10} J **05.** 550°C
06. a.) Q_{AB} = 3925 J, Q_{BC} = -2074 J, Q_{CD} = -1570 J, Q_{DA} = 691 J b.) Q_{DAB} = 4617 J c.) Q_{BCD} = -3644 J
06. d.) W_{AB} = -1621 J, W_{BC} = 0 J, W_{CD} = 648 J, W_{DA} = 0 J e.) W_{ABCDA} = -973 J f.) 21.1%
06. g.) Q_{ABCDA} = 973 J h.) ΔU_{AB} = 2305 J, ΔU_{BC} = -2074 J, ΔU_{CD} = -922 J, ΔU_{DA} = 691 J i.) ΔU_{ABCDA} = 0 J
07. 5.0 **08.** a.) 3.13×10^9 J/s b.) 112 kg/s

Chapter 11
Heat and Thermodynamics
11.6 The Second Law of Thermodynamics-Entropy   Homework # 92

Refer to the tables of "Specific Heats" and "Latent Heats (at 1 atm)" on Homework #85 in this chapter.

I

01. What is the change in entropy of 22.6 kg of water at 0°C when it is frozen to ice at 0°C?

02. What is the change in entropy of 3.33 kg of water at 100°C when it is vaporized to steam at 100°C?

03. One kilogram of water is heated from its freezing point, 0°C to its boiling point, 100°C. Calculate the **APPROXIMATE** change in entropy of the water in the process.

II

04. A bucket containing 18.3 kg of water at 0°C is dumped onto a frozen lake with an extremely large quantity of ice at -10°C. Eventually, thermal equilibrium is established. Ignore any heat transfers with the air.
   a.) What is the change in entropy of the water from the bucket?
   b.) What is the change in entropy of the ice on the lake?
   c.) What is the total change in entropy of the universe?
   d.) Is this process spontaneous?

05. One end of a steel rod is placed in molten lava at 825°C, while the other end of the rod is placed in a large nearby lake at 15.6°C. The rate at which the rod conducts heat from the lava to the lake is 7.32 cal/s. [Note: The melting point of steel is around 1370°C.]
   a.) What is the rate of entropy change of the lake in this process?
   b.) What is the rate of entropy change of the lava in this process?
   c.) What is the rate of entropy change of the universe in this process?

06. One kilogram of water at 25.0°C is mixed with 1 kg of water at 85.0°C in a well-insulated container. Calculate the approximate change in entropy in the universe. (Is this spontaneous in nature?)

07. Four kilograms of water at 25.0°C is mixed with 1.50 kg of water at 85.0°C in a well-insulated container. Calculate the approximate change in entropy in the universe. (Is this spontaneous in nature?)

08. One kilogram of water at 25.0°C is mixed with 3.75 kg of water at 85.0°C in a well-insulated container. Calculate the approximate change in entropy in the universe. (Is this spontaneous in nature?)

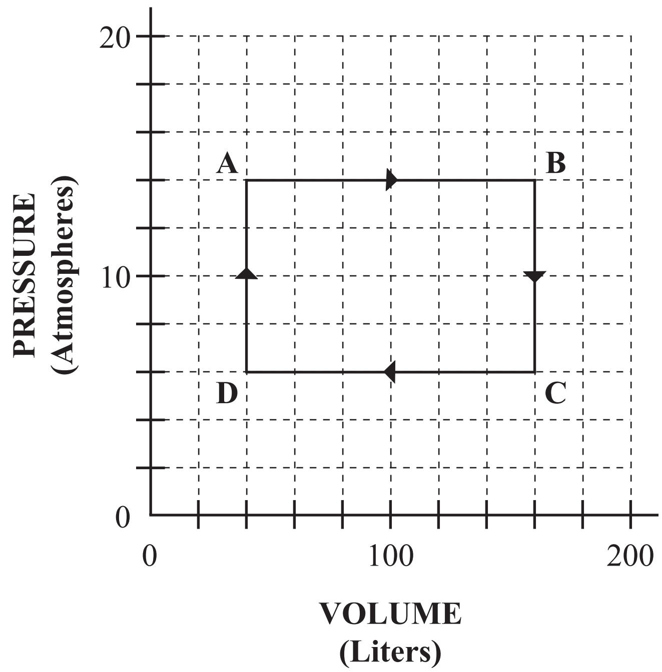
III

09. A real heat engine working between heat reservoirs at 125°C and 425°C produces 600 J of work per cycle by absorbing 1800 J of heat at the hot reservoir.
   a.) What is the actual efficiency of this real heat engine?
   b.) What is the Carnot efficiency of a heat engine working between these two reservoirs?
   c.) What is the second law efficiency of this real heat engine?
   d.) Calculate the total entropy change of the universe per cycle for this real heat engine?
   e.) Calculate the total entropy change of the universe per cycle of a Carnot engine working between these two reservoirs?

ANSWERS: **01.** -27.6 kJ/K **02.** 20.2 kJ/K **03.** 1294 J/K **04.** a.) -23.8 kJ/K b.) 24.6 kJ/K c.) 0.9 kJ/K **04.** d.) yes ($\Delta S_{univ} > 0$) **05.** a.) 0.1062 J/K·s b.) -0.02791 J/K·s c.) 0.0783 J/K·s **06.** 35.0 J/K (yes) **07.** 85.0 J/K (yes) **08.** 54.0 J/K (yes) **09.** a.) 33.3% b.) 43.0% c.) 77.6% d.) 0.436 J/K e.) 0 J/K

Chapter 11
Heat and Thermodynamics
The First Law of Thermodynamic-Review — Homework # 93

Questions 01-06 refer to the diagram to the right which describes 5.50 moles of a monatomic ideal gas with specific heats of C_V = 12.472 J/mol•K and C_P = 20.786 J/mol•K used in the operation of an ideal internal combustion engine.



01. Determine how much work was done during each of the following pathways.
    a.) AB
    b.) BC
    c.) CD
    d.) DA
    e.) ABCDA

02. Determine the temperature of this sample of gas at each of the following points.
    a.) A b.) B c.) C d.) D

03. Determine how much heat was put in (+) or taken out (-) during each of the following pathways.
    a.) AB b.) BC c.) CD d.) DA e.) BCD f.) DAB g.) ABCDA
    h.) How much heat was added to the system during one cycle?
    i.) How much heat was emitted from the system during one cycle?
    j.) What was the net heat flow during one cycle?

04. Determine how much internal energy this sample of gas has at each of the following points.
    a.) A b.) B c.) C d.) D

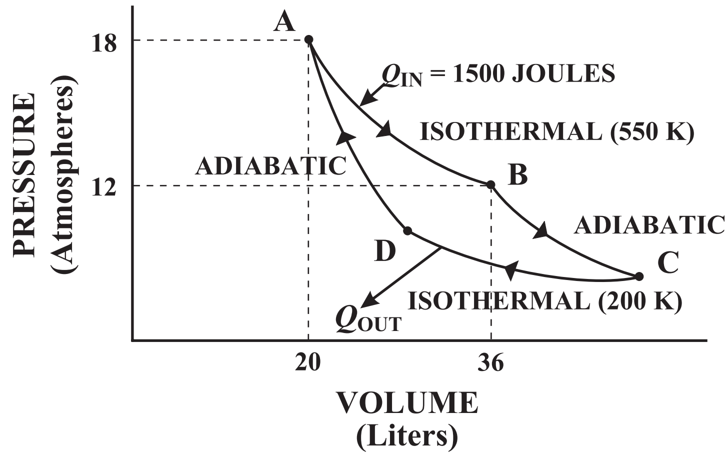
05. Using two different methods for each of the following pathways, determine the change in internal energy of this sample.
    a.) AB b.) BC c.) CD d.) DA e.) AC f.) BD g.) CA h.) DB i.) ABC j.) BCD
    k.) CDA l.) DAB m.) CBA n.) DCB o.) ADC p.) BAD q.) ABCDA r.) BCDAB
    s.) CDABC t.) DABCD u.) DCBAD v.) CBADC w.) BADCB x.) ADCBA

06. What is the thermal efficiency of this heat engine?

01. a.) -1.70×10^5 J b.) 0 J c.) 7.29×10^4 J d.) 0 J e.) -9.72×10^4 J
02. a.) 1241 K b.) 4962 K c.) 2127 K d.) 532 K
03. a.) 4.25×10^5 J b.) -1.95×10^5 J c.) -1.82×10^5 J d.) 4.86×10^4 J e.) -3.77×10^5 J
03. f.) 4.74×10^5 J g.) 9.72×10^4 J h.) 4.74×10^5 J i.) $- 3.77 \times 10^5$ J j.) 9.72×10^4 J
04. a.) 8.51×10^4 J b.) 3.40×10^5 J c.) 1.46×10^5 J d.) 3.65×10^4 J
05. a.) 2.55×10^5 J b.) $- 1.95 \times 10^5$ J c.) $- 1.09 \times 10^5$ J d.) 4.86×10^4 J e.) 6.08×10^4 J
05. f.) -3.04×10^5 J g.) -6.08×10^4 J h.) 3.04×10^5 J i.) 6.08×10^4 J j.) -3.04×10^5 J
05. k.) -6.08 x 104 J l.) 3.04×10^5 J m.) -6.08×10^4 J n.) 3.04×10^5 J o.) 6.08×10^4 J
05. p.) -3.04×10^5 J q.) 0 J r.) 0 J s.) 0 J t.) 0 J u.) 0 J v.) 0 J w.) 0 J x.) 0 J **06.** 20.5%

Chapter 11
Heat and Thermodynamics
The Second Law of Thermodynamics-Review — Homework # 94

The PV diagram to the right represents the states of an ideal gas during one cycle of operation of a reversible heat engine. The cycle consists of four processes. As shown on the diagram, 1500 J of heat enters the system during the isothermal process AB.



01. What will be the change in the internal energy of the gas during the process AB?

02. How much work is done by this gas during the process AB?

03. What will be the thermal efficiency of this system during one complete cycle?

04. How much heat, Q_{out}, will be exhausted during process CD?

05. What will be the **NET** work done by this system during each complete cycle?

06. How much heat will be absorbed by this system during the process DA?

07. How will the thermal energy of this gas at state C compare with the internal energy at state D?

01. 0 J **02.** -1500 J **03.** 63.6% **04.** 546 J **05.** -954 J **06.** 0 J **07.** 0 J