Extra Practice 1

Due: 7:00am on Wednesday, June 8, 2016

To understand how points are awarded, read the Grading Policy for this assignment.

Exercise 17.11

The Humber Bridge in England has the world's longest single span, 1410 m .

Part A

Calculate the change in length of the steel deck of the span when the temperature increases from -4.0 $^\circ\mathrm{C}$ to 18.5 $^\circ\mathrm{C}$.

Express your answer using two significant figures.

ANSWER:

ΔL = 0.38 m

Correct

Exercise 17.13

A U.S. penny has a diameter of 1.9000 cm at 20.0 $^\circ\mathrm{C}$. The coin is made of a metal alloy (mostly zinc) for which the coefficient of linear expansion is $2.6 \times 10^{-5}\mathrm{K}^{-1}$.

Part A

What would its diameter be on a hot day in Death Valley (49 $^\circ\mathrm{C}$)?

Express your answer using five significant figures.

ANSWER:

d_1 = 1.9014 cm

Correct

Part B

On a cold night in the mountains of Greenland (-53 $^\circ\mathrm{C}$)?

Express your answer using five significant figures.

ANSWER:

d_2 = 1.8964 cm

Correct

Exercise 17.12

The tallest building in the world, according to some architectural standards, is the Taipei 101 in Taiwan, at a height of 1671 feet. Assume that this height was measured on a cool spring day when the temperature was 12.0 $^\circ\mathrm{C}$. You could use the building as a sort of giant thermometer on a hot summer day by carefully measuring its height. Suppose you do this and discover that the Taipei 101 is 0.494 foot taller than its official height.

Part A

What is the temperature, assuming that the building is in thermal equilibrium with the air and that its entire frame is made of steel?

ANSWER:

T = $^\circ\mathrm{C}$

Exercise 17.14

Aluminum rivets used in airplane construction are made slightly larger than the rivet holes and cooled by "dry ice" (solid $\mathrm{CO_2}$) before being driven.

Part A

If the diameter of a hole is 4.500 mm, what should be the diameter of a rivet at 23.0 $^\circ\mathrm{C}$, if its diameter is to equal that of the hole when the rivet is cooled to - 78.0 $^\circ\mathrm{C}$, the temperature of dry ice? Assume that the expansion coefficient of aluminum is $2.4 \times 10^{-5}\ (^\circ\mathrm{C})^{-1}$ and remains constant.

Express your answer using four significant figures.

ANSWER:

d = mm

Exercise 17.21

Steel train rails are laid in 12.5-m-long segments placed end to end. The rails are laid on a winter day when their temperature is -2.0 $^\circ\mathrm{C}$.

Part A

How much space must be left between adjacent rails if they are just to touch on a summer day when their temperature is 35.0 $^\circ\mathrm{C}$?

Express your answer to two significant figures and include the appropriate units.

ANSWER:

D =

Part B

If the rails are originally laid in contact, what is the stress in them on a summer day when their temperature is 35.0 $^\circ\mathrm{C}$?

Express your answer using two significant figures. Enter positive value if the stress is tensile and negative value if the stress is compressive.

ANSWER:

$\frac{F}{A}$ = Pa

± Concorde in Flight

The supersonic aircraft Concorde has a length of 62.3 m when sitting on the ground on a typical day when the temperature is 18.0 $^\circ\mathrm{C}$. The Concorde is primarily made of aluminum. In flight at twice the speed of sound, friction with the air warms the Concorde's skin and causes the aircraft to lengthen by 29.0 cm . (The passenger cabin is on rollers, so the airplane expands around the passenger cabin.)

Take the coefficient of linear expansion for aluminum to be α = 2.40×10^{-5} $/^\circ\mathrm{C}$.

Part A

What is the temperature T of the Concorde's skin in flight?

You did not open hints for this part.

ANSWER:

T = ______ $^\circ\mathrm{C}$

Hot Rods

Two circular rods, both of length L and having the same diameter, are placed end to end between rigid supports with no initial stress in the rods.

The coefficient of linear expansion and Young's modulus for rod A are α_A and Y_A respectively; those for rod B are α_B and Y_B respectively. Both rods are "normal" materials with $\alpha > 0$.

The temperature of the rods is now raised by ΔT.

Part A

After the rods have been heated, which of the following statements is true?

Choose the best answer.

ANSWER:

- The length of each rod is still L.
- The length of each rod changes but the combined length of the rods is still $2L$.

Part B

This question will be shown after you complete previous question(s).

Part C

This question will be shown after you complete previous question(s).

The Incredible Shrinking (and Expanding) Bridge

Learning Goal:

To understand thermal linear expansion in solid materials.

Most materials expand when their temperatures increase. Such *thermal expansion*, which is explained by the increase in the average distance between the constituent molecules, plays an important role in engineering. In fact, as the temperature increases or decreases, the changes in the dimensions of various parts of bridges, machines, etc., may be significant enough to cause trouble if not taken into account. That is why power lines are always sagging and parts of metal bridges fit loosely together, allowing for some movement.
It turns out that for relatively small changes in temperature, the linear dimensions change in direct proportion to the temperature. For instance, if a rod has

length L_0 at a certain temperature T_0 and length L at a higher temperature T, then the change in length of the rod is proportional to the change in temperature and to the initial length of the rod:

$$L - L_0 = \alpha L_0 (T - T_0),$$

or

$$\Delta L = \alpha L_0 \Delta T.$$

Here, α is a constant called the *coefficient of linear expansion*; its value depends on the material. A large value of α means that the material expands substantially as the temperature increases; smaller values of α indicate that the material tends to retain its dimensions. For instance, quartz does not expand much; aluminum expands a lot. The value of α for aluminum is about 60 times that of quartz!
In this problem, you will answer some basic questions related to the concept of thermal expansion.

Part A

A square is cut out of a copper sheet. The square is heated uniformly. As a result, it turns into

ANSWER:

- a square with a larger area
- a square with a smaller area
- a rectangle with a larger area
- a rectangle with a smaller area

Part B

This question will be shown after you complete previous question(s).

Part C

This question will be shown after you complete previous question(s).

The next few questions refer to the Golden Great Bridge, built on planet Tehar in a galaxy far, far away. The bridge-building technology on Tehar is not very well developed: The bridge is just a long slab of pure gold with the opposite ends resting on the shores of the river.
In the spring, when the air temperature is 100 $^\circ\mathrm{C}$, the length of the bridge is 160.0 m. Answer the questions below knowing that the value of α for gold is $1.42 \times 10^{-5}\ ^\circ\mathrm{C}^{-1}$.

Part D

Compared to its length in the spring, by what amount $\Delta L_{\mathrm{winter}}$ does the length of the bridge decrease during the Teharian winter when the temperature hovers around -150$^\circ\mathrm{C}$?

Express your answer as a positive value in meters.

ANSWER:

$\Delta L_{\mathrm{winter}}$ = ______ m

Part E

Compared to its length in the spring, by what amount $\Delta L_{\mathrm{summer}}$ does the length of the bridge increase during the Teharian summer when the temperature hovers around 700$^\circ\mathrm{C}$?

Express your answer numerically in meters.

ANSWER:

$\Delta L_{\mathrm{summer}}$ = [ ] m

Part F

This question will be shown after you complete previous question(s).

Exercise 17.23

An aluminum tea kettle with mass 1.10 kg and containing 1.90 kg of water is placed on a stove.

Part A

If no heat is lost to the surroundings, how much heat must be added to raise the temperature from 22.0 $^\circ\mathrm{C}$ to 82.0 $^\circ\mathrm{C}$?

ANSWER:

Q = [ ] J

Exercise 17.24

In an effort to stay awake for an all-night study session, a student makes a cup of coffee by first placing a 200-W electric immersion heater in 0.300 kg of water.

Part A

How much heat must be added to the water to raise its temperature from 19.5 $^\circ\mathrm{C}$ to 86.5 $^\circ\mathrm{C}$?

ANSWER:

Q = [ ] J

Part B

How much time is required? Assume that all of the heater's power goes into heating the water.

ANSWER:

t = [ ] s

Exercise 17.29

While painting the top of an antenna 219 m in height, a worker accidentally lets a 1.00-L water bottle fall from his lunchbox. The bottle lands in some bushes at ground level and does not break.

Part A

If a quantity of heat equal to the magnitude of the change in mechanical energy of the water goes into the water, what is its increase in temperature?

ANSWER:

ΔT = ____ $^\circ\mathrm{C}$

Exercise 17.30

A 26000 kg subway train initially traveling at 15.0 $\mathrm{m/s}$ slows to a stop in a station and then stays there long enough for its brakes to cool. The station's dimensions are 65.0 m long by 20.0 m wide by 12.0 m high.

Part A

Assuming all the work done by the brakes in stopping the train is transferred as heat uniformly to all the air in the station, by how much does the air temperature in the station rise? Take the density of the air to be 1.20 $\mathrm{kg/m^3}$ and its specific heat to be 1020 $\mathrm{J/(kg \cdot K)}$.

ANSWER:

ΔT = ____ $^\circ\mathrm{C}$

Exercise 17.33

A 15.8 g bullet traveling horizontally at 868 $\mathrm{m/s}$ passes through a tank containing 13.6 kg of water and emerges with a speed of 538 $\mathrm{m/s}$.

Part A

What is the maximum temperature increase that the water could have as a result of this event?

ANSWER:

ΔT = ____ $^\circ\mathrm{C}$

Specific Heat, Latent Heat, and Temperature versus Time Graphs

Learning Goal:

To understand specific heat and latent heat and how they are related to temperature versus time graphs.

Energy can be added to a system either by doing work W on it or by adding heat Q to it. Energy transfer by work requires a force to act through some distance. Energy transfer in the form of heat occurs between objects that are at different temperatures, with energy spontaneously traveling from the higher-temperature object to the lower-temperature one. When energy is added to an isolated system in the form of heat, either the temperature T of the system will increase or the system will undergo a phase change at a fixed temperature.

The specific heat c of a sample characterizes the rate at which it changes temperature per unit mass when it receives energy in the form of heat. The relationship between the energy input in the form of heat Q and the resulting temperature change ΔT is

$$Q = mc\Delta T,$$

where m is the mass of the sample and c is its specific heat, which depends on its phase. For this problem, assume that specific heat values are a constant for all temperatures within a given phase, which is a good approximation.

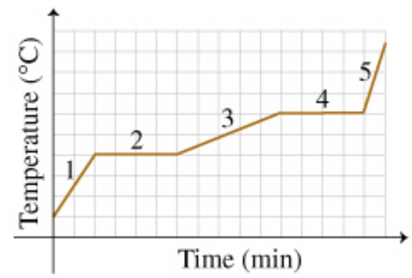
The latent heat L of a sample characterizes how much energy is required per unit mass to force the system to undergo a phase change at a fixed temperature. The amount of energy input in the form of heat Q required to completely change the phase of a sample with mass m is

$$Q = mL.$$

Phase changes between solid and liquid phases are characterized by a latent heat of fusion L_f . Phase changes between liquid and gas phases are characterized by a latent heat of vaporization L_v .

In general, every phase (solid, liquid, or gas) has its own specific heat value and every phase change has its own latent heat value.

This graph in shows how the temperature of an initially solid sample changes as time goes by when it is placed above a flame that delivers a constant heating power (that is, a fixed amount of energy input in the form of heat each second). The process occurs in five distinct steps:



1. Increase the temperature of the solid until it reaches its melting temperature.
2. Melt the solid to form a liquid, maintaining a constant temperature.
3. Increase the temperature of the liquid until it reaches its boiling temperature.
4. Boil away all the liquid to form a gas, maintaining a constant temperature.
5. Increase the temperature of the gas (this assumes that the gaseous sample is confined).

Part A

Use the graph to rank the sizes of the following:

A. specific heat of the solid, c_{s}
B. specific heat of the liquid, c_{l}
C. specific heat of the gas, c_{g}

Keep in mind that energy is being delivered to the system in the form of heat at a constant rate by the flame.

Rank from largest to smallest specific heat. To rank items as equivalent, overlap them.

You did not open hints for this part.

ANSWER:

Part B

Use the graph to rank the sizes of the following.

A. latent heat of fusion, L_{f}
B. latent heat of vaporization, L_{v}

Keep in mind that energy is being delivered to the system in the form of heat at a constant rate by the flame.

Rank from largest to smallest latent heat. To rank items as equivalent, overlap them.

You did not open hints for this part.

ANSWER:

Part C

This question will be shown after you complete previous question(s).

Part D

This question will be shown after you complete previous question(s).

Part E

This question will be shown after you complete previous question(s).

Part F

This question will be shown after you complete previous question(s).

Exercise 20.2

An aircraft engine takes in an amount 9100 J of heat and discards an amount 6600 J each cycle.

Part A

What is the mechanical work output of the engine during one cycle?

ANSWER:

W = J

Part B

What is the thermal efficiency of the engine?

Express your answer as a percentage.

ANSWER:

e = %

Exercise 20.3

A gasoline engine takes in 1.46×10^4 J and delivers 3900 J of work per cycle. The heat is obtained by burning gasoline with a heat of combustion of 4.60×10^4 $\mathrm{J/g}$.

Part A

What is the thermal efficiency?

ANSWER:

e =

Part B

How much heat is discarded in each cycle?

ANSWER:

J

Part C

What mass of fuel is burned in each cycle?

ANSWER:

m = g

Part D

If the engine goes through 70.0 cycles per second, what is its power output in kilowatts?

ANSWER:

kW

Part E

If the engine goes through 70.0 cycles per second, what is its power output in horsepower?

ANSWER:

hp

Exercise 20.4

A gasoline engine has a power output of 200 kW (about 2.68×10^5 hp). Its thermal efficiency is 30.0 $\%$.

Part A

How much heat must be supplied to the engine per second?

ANSWER:

$\mathrm{J/s}$

Part B

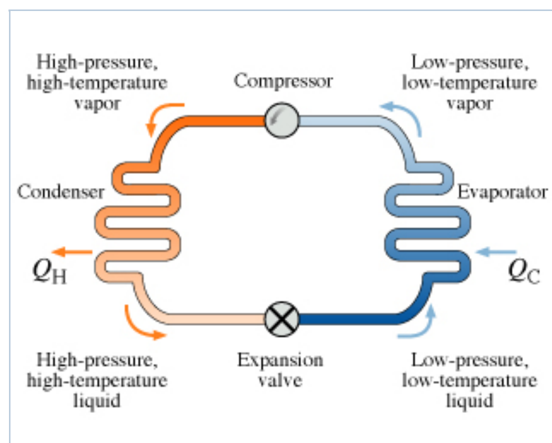
How much heat is discarded by the engine per second?

ANSWER:

$\mathrm{J/s}$

An Air Conditioner: Refrigerator or Heat Pump?

The typical operation cycle of a common refrigerator is shown schematically in the figure . Both the condenser coils to the left and the evaporator coils to the right contain a fluid (the working substance) called refrigerant, which is typically in vapor-liquid phase equilibrium. The compressor takes in low-pressure, low-temperature vapor and compresses it adiabatically to high-pressure, high-temperature vapor, which then reaches the condenser. Here the refrigerant is at a higher temperature than that of the air surrounding the condenser coils and it releases heat by undergoing a phase change. The refrigerant leaves the condenser coils as a high-pressure, high-temperature liquid and expands adiabatically at a controlled rate in the expansion valve. As the fluid expands, it cools down. Thus, when it enters the evaporator coils, the refrigerant is at a lower temperature than its surroundings and it absorbs heat. The air surrounding the evaporator cools down and most of the refrigerant in the evaporator coils vaporizes. It then reaches the compressor as a low-pressure, low-temperature vapor and a new cycle begins.



Part A

Air conditioners operate on the same principle as refrigerators. Consider an air conditioner that has 7.00 kg of refrigerant flowing through its circuit each cycle. The refrigerant enters the evaporator coils in phase equilibrium, with 54.0 $\%$ of its mass as liquid and the rest as vapor. It flows through the evaporator at a constant pressure and when it reaches the compressor 95$\%$ of its mass is vapor. In each cycle, how much heat Q_c is absorbed by the refrigerant while it is in the evaporator? The heat of vaporization of the refrigerant is 1.50×10^5 $\mathrm{J/kg}$.

Express your answer numerically in joules.

You did not open hints for this part.

ANSWER:

Q_c = [ ] J

Part B

In each cycle, the change in internal energy of the refrigerant when it leaves the compresser is 1.20×10^5 J . What is the work W done by the motor of the compressor?

Express your answer in joules.

You did not open hints for this part.

ANSWER:

W = [ ] J

Part C

This question will be shown after you complete previous question(s).

Exercise 20.9

A refrigerator has a coefficient of performance of 2.20. Each cycle it absorbs 3.31×10^4 J of heat from the cold reservoir.

Part A

How much mechanical energy is required each cycle to operate the refrigerator?

Express your answer with the appropriate units.

ANSWER:

$|W|$ = [ ]

Part B

During each cycle, how much heat is discarded to the high-temperature reservoir?

Express your answer with the appropriate units.

ANSWER:

$|Q_H|$ = [ ]

Exercise 20.10

A freezer has a coefficient of performance of 2.40. The freezer is to convert 1.80 kg of water at 25.0 $^\circ\mathrm{C}$ to 1.80 kg of ice at - 5.0 $^\circ\mathrm{C}$ in one hour.

Part A

What amount of heat must be removed from the water at 25.0 $^\circ\mathrm{C}$ to convert it to ice at - 5.0 $^\circ\mathrm{C}$?

ANSWER:

$|Q_C|$ = ______ J

Part B

How much electrical energy is consumed by the freezer during this hour?

ANSWER:

W = ______ J

Part C

How much wasted heat is rejected to the room in which the freezer sits?

ANSWER:

$|Q_H|$ = ______ J

Exercise 20.11

A refrigerator has a coefficient of performance of 2.25, runs on an input of 135 W of electrical power, and keeps its inside compartment at 5$^\circ\mathrm{C}$.

Part A

If you put a dozen 1.0-L plastic bottles of water at 31$^\circ\mathrm{C}$ into this refrigerator, how long will it take for them to be cooled down to 5$^\circ\mathrm{C}$? (Ignore any heat that leaves the plastic.)

ANSWER:

t = ______ min

Refrigerator Prototypes Ranking Task

Six new refrigerator prototypes are tested in the laboratory. For each refrigerator, the electrical power P needed for it to operate and the maximum heat energy that can be removed per second $Q_{\mathrm{C,max}}/\Delta t$ from its interior are given.

Part A

Rank these refrigerators on the basis of their performance coefficient.

Rank from largest to smallest. To rank items as equivalent, overlap them.

You did not open hints for this part.

ANSWER:

Part B

The six refrigerators are placed in six identical sealed rooms. Rank the refrigerators on the basis of the rate at which they raise the temperature of the room.

Rank from largest to smallest. To rank items as equivalent, overlap them.

You did not open hints for this part.

ANSWER:

Exercise 20.12

A Carnot engine is operated between two heat reservoirs at temperatures of 520 K and 300 K.

Part A

If the engine receives 6.45 kJ of heat energy from the reservoir at 520 K in each cycle, how many joules per cycle does it reject to the reservoir at 300 K?

ANSWER:

J

Part B

How much mechanical work is performed by the engine during each cycle?

ANSWER:

J

Part C

What is the thermal efficiency of the engine?

ANSWER:

e = $\%$

Exercise 20.13

A Carnot engine whose high-temperature reservoir is at 620 K takes in 550 J of heat at this temperature in each cycle and gives up 335 J to the low-temperature reservoir.

Part A

How much mechanical work does the engine perform during each cycle?

ANSWER:

W = ______ J

Part B

What is the temperature of the low-temperature reservoir?

ANSWER:

T = ______ K

Part C

What is the thermal efficiency of the cycle?

ANSWER:

e = ______ %

Exercise 20.14

An ice-making machine operates in a Carnot cycle. It takes heat from water at 0.0 $^\circ\mathrm{C}$ and rejects heat to a room of temperature 24.0 $^\circ\mathrm{C}$. Suppose that a mass 82.5 kg of water at 0.0 $^\circ\mathrm{C}$ is converted to ice at 0.0 $^\circ\mathrm{C}$.

Part A

How much heat is rejected to the room?

ANSWER:

$|Q_H|$ = ______ J

Part B

How much energy must be supplied to the device?

ANSWER:

$|W|$ = ______ J

Exercise 20.15

A Carnot engine has an efficiency of 66 $\%$ and performs 3.1×10^4 J of work in each cycle.

Part A

How much heat does the engine extract from its heat source in each cycle?

Express your answer with the appropriate units.

ANSWER:

$|Q_H|$ =

Part B

Suppose the engine exhausts heat at room temperature (20.0$^\circ\mathrm{C}$). What is the temperature of its heat source?

ANSWER:

T_H = $^\circ\mathrm{C}$

Exercise 20.17

A Carnot refrigerator is operated between two heat reservoirs at temperatures of 320 K and 270 K.

Part A

If in each cycle the refrigerator receives 415 J of heat energy from the reservoir at 270 K, how many joules of heat energy does it deliver to the reservoir at 320 K?

ANSWER:

J

Part B

If the refrigerator goes through 165 cycles each minute, what power input is required to operate the refrigerator?

ANSWER:

W

Part C

What is the coefficient of performance of the refrigerator?

ANSWER:

Exercise 20.18

A Carnot heat engine uses a hot reservoir consisting of a large amount of boiling water and a cold reservoir consisting of a large tub of ice and water. In five minutes of operation of the engine, the heat rejected by the engine melts 0.0400 kg of ice.

Part A

During this time, how much work W is performed by the engine?

ANSWER:

W = ______ J

Exercise 20.16

A certain brand of freezer is advertised to use 880 $\mathrm{kW \cdot h}$ of energy per year.

Part A

Assuming the freezer operates for 6 hours each day, how much power does it require while operating?

Express your answer using two significant figures.

ANSWER:

P = ______ W

Part B

If the freezer keeps its interior at a temperature of -6.0 $^\circ\mathrm{C}$ in a 20.0 $^\circ\mathrm{C}$ room, what is its theoretical maximum performance coefficient?

ANSWER:

K = ______

Part C

What is the theoretical maximum amount of ice this freezer could make in an hour, starting with water at 20.0 $^\circ\mathrm{C}$?

ANSWER:

m = ______ kg

Melting Ice with a Carnot Engine

A Carnot heat engine uses a hot reservoir consisting of a large amount of boiling water and a cold reservoir consisting of a large tub of ice and water. In 5 minutes of operation of the engine, the heat rejected by the engine melts a mass of ice equal to 3.60×10^{-2} kg .

Throughout this problem use $L_{\rm f} = 3.34 \times 10^5 \ \mathrm{J/kg}$ for the heat of fusion for water.

Part A

During this time, how much work W is performed by the engine?

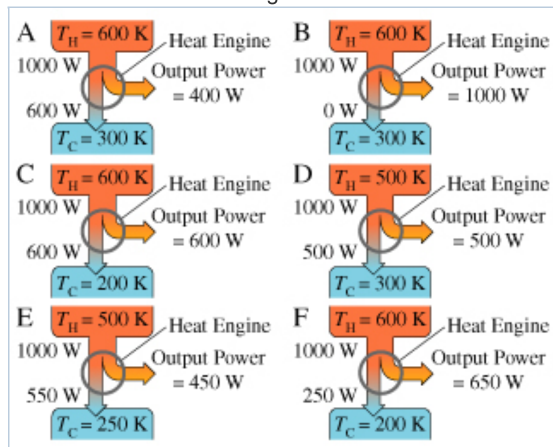
You did not open hints for this part.

ANSWER:

W = [ ] J

Six New Heat Engines Conceptual Question

As part of your job at the patent office, you are asked to evaluate the six designs shown in the figure for innovative new heat engines.



Part A

Which of the designs violate(s) the first law of thermodynamics?

Give the letter(s) of the design(s) in alphabetical order, without commas or spaces (e.g., ACD).

You did not open hints for this part.

ANSWER:

Part B

This question will be shown after you complete previous question(s).

Part C

This question will be shown after you complete previous question(s).

The Carnot Icemaker

An ice-making machine inside a refrigerator operates in a Carnot cycle. It takes heat from liquid water at 0.0 $^\circ\mathrm{C}$ and rejects heat to a room at a temperature of 21.2 $^\circ\mathrm{C}$. Suppose that liquid water with a mass of 88.7 kg at 0.0 $^\circ\mathrm{C}$ is converted to ice at the same temperature.

Take the heat of fusion for water to be L_f = 3.34×10^5 $\mathrm{J/kg}$.

Part A

How much heat $|Q_{\rm H}|$ is rejected to the room?

Express your answer in joules to four significant figures.

You did not open hints for this part.

ANSWER:

$|Q_{\rm H}|$ = ______ $\rm J$

Part B

This question will be shown after you complete previous question(s).

Problem 20.33

An ideal Carnot engine operates between 510 $^\circ \rm C$ and 100 $^\circ \rm C$ with a heat input of 270 $\rm J$ per cycle.

Part A

How much heat is delivered to the cold reservoir in each cycle?

ANSWER:

$|Q_C|$ = ______ $\rm J$

Part B

What minimum number of cycles are necessary for the engine to lift a rock of mass 490 $\rm kg$ through a height of 115 $\rm m$?

ANSWER:

______ cycles

Problem 20.35

A certain heat engine operating on a Carnot cycle absorbs 390 $\rm J$ of heat per cycle at its hot reservoir at 125 $^\circ \rm C$ and has a thermal efficiency of 22.0 $\%$.

Part A

How much work does this engine do per cycle?

Express your answer to two significant figures and include the appropriate units.

ANSWER:

W = ______

Part B

How much heat does the engine waste each cycle?

Express your answer to two significant figures and include the appropriate units.

ANSWER:

$|Q|$ =

Part C

What is the temperature of the cold reservoir?

Express your answer to two significant figures and include the appropriate units.

ANSWER:

T_c = $^{\circ}\mathrm{C}$

Part D

By how much does the engine change the entropy of the world each cycle?

Express your answer to two significant figures and include the appropriate units.

ANSWER:

ΔS =

Part E

What mass of water could this engine pump per cycle from a well 25.0 m deep?

Express your answer to two significant figures and include the appropriate units.

ANSWER:

m =

Problem 20.48

A typical coal-fired power plant generates 1000 MW of usable power at an overall thermal efficiency of 40%.

Part A

What is the rate of heat input to the plant?

ANSWER:

P_H = MW

Part B

The plant burns anthracite coal, which has a heat of combustion of $2.65 \times 10^7\ \mathrm{J/kg}$. How much coal does the plant use per day, if it operates continuously?

ANSWER:

m = [ ] kg

Part C

At what rate is heat ejected into the cool reservoir, which is the nearby river?

ANSWER:

P_C = [ ] MW

Part D

The river's temperature is 18.0 $^\circ\mathrm{C}$ before it reaches the power plant and 18.6 $^\circ\mathrm{C}$ after it has received the plant's waste heat. Calculate the river's flow rate, in cubic meters per second.

ANSWER:

V = [ ] $\mathrm{m^3/s}$

Part E

By how much does the river's entropy increase each second?

ANSWER:

ΔS = [ ] $\mathrm{J/K}$

Exercise 17.59

A carpenter builds an exterior house wall with a layer of wood 3.1 cm thick on the outside and a layer of Styrofoam insulation 2.4 cm thick on the inside wall surface. The wood has $k =$0.080$\mathrm{W/(m \cdot K)}$, and the Styrofoam has $k =$ 0.010 $\mathrm{W/(m \cdot K)}$. The interior surface temperature is 20.0 $^\circ\mathrm{C}$, and the exterior surface temperature is -14.0 $^\circ\mathrm{C}$.

Part A

What is the temperature at the plane where the wood meets the Styrofoam?

Express your answer using two significant figures.

ANSWER:

T = [ ] $^\circ\mathrm{C}$

Part B

What is the rate of heat flow per square meter through this wall?

Express your answer using two significant figures.

ANSWER:

H = [ ] $\mathrm{W/m^2}$

Exercise 17.61

The blood plays an important role in removing heat from the body by bringing this heat directly to the surface where it can radiate away. Nevertheless, this heat must still travel through the skin before it can radiate away. We shall assume that the blood is brought to the bottom layer of skin at a temperature of 37.0 $^\circ\mathrm{C}$ and that the outer surface of the skin is at 30.3 $^\circ\mathrm{C}$. Skin varies in thickness from 0.500 mm to a few millimeters on the palms and soles, so we shall assume an average thickness of 0.760 mm . A 165 lb , 6.00 ft person has a surface area of about 2.00 $\mathrm{m^2}$ and loses heat at a net rate of 76.0 W while resting.

Part A

On the basis of our assumptions, what is the thermal conductivity of this person's skin?

ANSWER:

K = [ ] $\mathrm{W/(K \cdot m)}$

Exercise 17.60

An electric kitchen range has a total wall area of 1.40 $\mathrm{m^2}$ and is insulated with a layer of fiberglass 4.0 cm thick. The inside surface of the fiberglass has a temperature of 175 $^\circ\mathrm{C}$ and its outside surface is at 35 $^\circ\mathrm{C}$. The fiberglass has a thermal conductivity of 0.040 $\mathrm{W/(m \cdot K)}$.

Part A

What is the heat current through the insulation, assuming it may be treated as a flat slab with an area of 1.40 $\mathrm{m^2}$?

Express your answer using two significant figures.

ANSWER:

H = [ ] W

Part B

What electric-power input to the heating element is required to maintain this temperature?

Express your answer using two significant figures.

ANSWER:

[ ] W

Problem 17.99

A carpenter builds a solid wood door with dimensions 2.00 $\mathrm{m} \times 0.90\ \mathrm{m} \times 4.0\ \mathrm{cm}$. Its thermal conductivity is k=0.120$\mathrm{W/(m \cdot K)}$. The air films on the inner and outer surfaces of the door have the same combined thermal resistance as an additional 1.5 cm thickness of solid wood. The inside air temperature is 17.0 $^\circ\mathrm{C}$, and the outside air temperature is -9.00 $^\circ\mathrm{C}$.

Part A

What is the rate of heat flow through the door?

Express your answer using two significant figures.

ANSWER:

H = ______ W

Part B

By what factor is the heat flow increased if a window 0.520 m on a side is inserted in the door? The glass is 0.5 cm , and the glass has a thermal conductivity of 0.80 $\mathrm{W/(m \cdot K)}$. The air films on the two sides of the glass have a total thermal resistance that is the same as an additional 11.0 cm of glass.

Express your answer using two significant figures.

ANSWER:

$\frac{H_{\mathrm{glass}}}{H}$ = ______

Score Summary:

Your score on this assignment is 5.1%.
You received 10 out of a possible total of 195 points.