Assignment-2

Due: 3:00pm on Tuesday, February 14, 2012

Note: You will receive no credit for late submissions. To learn more, read your instructor's Grading Policy

[Switch to Standard Assignment View]

Exercise 18.38

Part A

Calculate the mean free path of air molecules at a pressure of $1.50\times10^{-13}\ \text{atm}$ and a temperature of $294\ \text{K}$. (This pressure is readily attainable in the laboratory.) Model the air molecules as spheres with a radius of $2.00\times10^{-10}\ \text{m}$.

ANSWER: λ = **3.76×10^5** *Correct* m

Problem 19.52

A cylinder with a frictionless, movable piston like that shown in the Figure 19.5 in the textbook, contains a quantity of helium gas. Initially the gas is at a pressure of $1.00\times10^5\ \text{Pa}$, has a temperature of $300\ \text{K}$, and occupies a volume of $1.50\ \text{L}$. The gas then undergoes two processes. In the first, the gas is heated and the piston is allowed to move to keep the temperature equal to $300\ \text{K}$. This continues until the pressure reaches $2.50\times10^4\ \text{Pa}$. In the second process, the gas is compressed at constant pressure until it returns to its original volume of $1.50\ \text{L}$. Assume that the gas may be treated as ideal.

Part A

Find the volume of the gas at the end of the first process.

ANSWER: V_1 = **6.00** *Correct* L

Part B

Find the pressure of the gas at the end of the second process.

ANSWER: p_2 = **2.50×10^4** *Correct* Pa

Part C

Find the temperature of the gas at the end of the second process.

ANSWER: T_2 = **75.0** K
Correct

Part D

Find the total work done by the gas in the first process.

ANSWER: W_1 = **208** J
Correct

Part E

Find the total work done by the gas in the second process.

ANSWER: W_2 = **-113** J
Correct

Problem 19.62

A cylinder with a piston contains $0.250\ \text{mol}$ of oxygen at $2.40 \times 10^5\ \text{Pa}$ and $355\ \text{K}$. The oxygen may be treated as an ideal gas. The gas first expands isobarically to twice its original volume. It is then compressed isothermally back to its original volume, and finally it is cooled isochorically to its original pressure.

Part A

Compute the temperature during the isothermal compression.

ANSWER: T = **710** K
Correct

Part B

Compute the maximum pressure.

ANSWER: P = **4.80×10^5** Pa
Correct

Part C

Compute the total work done by the piston on the gas during the series of processes.

ANSWER: W = **285** J
Correct

Exercise 20.22

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

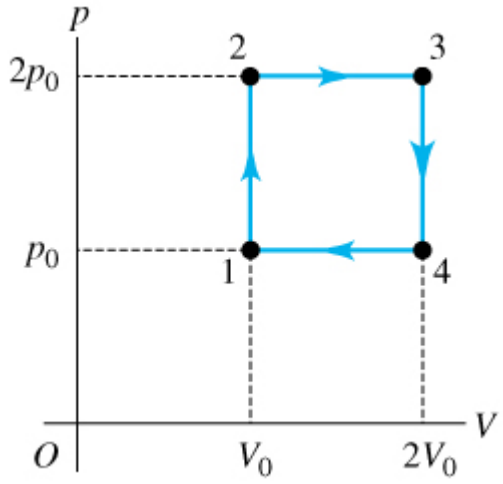
During this time, how much work W is performed by the engine?

ANSWER: W = **4890** J
Correct

Problem 20.46

Part A

What is the thermal efficiency of an engine that operates by taking n moles of diatomic ideal gas through the cycle $1 \to 2 \to 3 \to 4 \to 1$ shown in the figure ?



ANSWER: e = **10.5** %
Correct

Exercise 20.26

You decide to take a nice hot bath but discover that your thoughtless roommate has used up most of the hot water. You fill the tub with 270 kg of 30.0 $^\circ\text{C}$ water and attempt to warm it further by pouring in 5.00 kg of boiling water from the stove.

Part A

Is this a reversible or an irreversible process?

ANSWER:

- an reversible process
- **an irreversible process**

Correct

Part B

Use physical reasoning to explain.

Essay answers are limited to about 500 words (3800 characters maximum, including spaces).

ANSWER:

My Answer:
since the heat of transfer between the boiling point of water and 30 degrees, it occurs over a finite temperature and the process is therefore irreversible

Part C

Calculate the final temperature of the bath water.

Express your answer using four significant figures.

ANSWER:

T = **31.27** $^\circ\text{C}$

Correct

Part D

Calculate the net change in entropy of the system (bath water + boiling water), assuming no heat exchange with the air or the tub itself.

Express your answer using two significant figures.

ANSWER:

ΔS = **470** J/K

Correct

Exercise 20.30

Part A

What is the change in entropy of helium gas with total mass 0.125 kg at the normal boiling point of helium when it all condenses isothermally to liquid helium? Assume that the normal boiling point of helium is 4.216 K and the heat of vaporization of helium is 2.09×10^4 $\mathrm{J/kg}$.

ANSWER: ΔS = **-620** ***Correct*** $\mathrm{J/K}$

Problem 20.52

A typical coal-fired power plant generates 1000 MW of usable power at an overall thermal efficiency of 35%.

Part A

What is the rate of heat input to the plant?

ANSWER: P_H = **2860** ***Correct*** MW

Part B

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

ANSWER: m = **9.32×10^6** ***Correct*** kg

Part C

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

ANSWER: P_C = **1860** ***Correct*** MW

Part D

The river's temperature is 18.0 $^\circ\mathrm{C}$ before it reaches the power plant and 18.4$^\circ\mathrm{C}$ after it has received the plant's waste heat. Calculate the river's flow rate, in cubic meters per second.

ANSWER: V = **1110** ***Correct*** $\mathrm{m^3/s}$

Part E

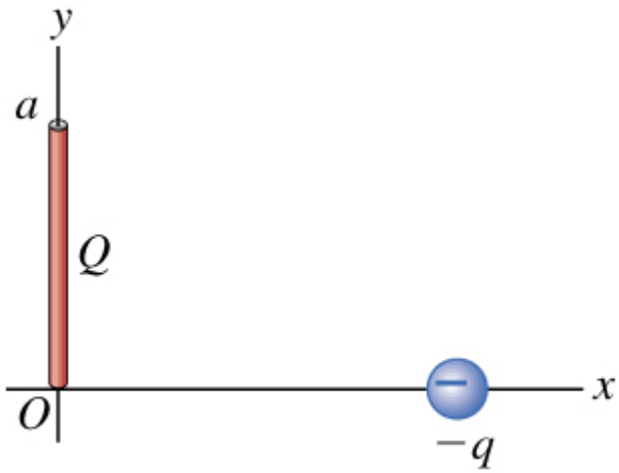
By how much does the river's entropy increase each second?

ANSWER: ΔS = **6.38×10⁶** J/K

Correct

Problem 21.90

Positive charge Q is distributed uniformly along the positive *y*-axis between $y = 0$ and $y = a$. A negative point charge $-q$ lies on the positive *x*-axis, a distance x from the origin (the figure).



Part A

Calculate the *x*-component of the electric field produced by the charge distribution Q at points on the positive *x*-axis.

Express your answer in terms of the variables Q, x, y, a and appropriate constants.

ANSWER: $E_x = \dfrac{Q}{4\pi\epsilon_0 x}\cdot\left(\dfrac{1}{\sqrt{x^2+a^2}}\right)$

Correct

Part B

Calculate the *y*-component of the electric field produced by the charge distribution Q at points on the positive *x*-axis.

Express your answer in terms of the variables Q, x, y, a and appropriate constants.

ANSWER: $E_y = -\dfrac{Q}{4\pi\epsilon_0 a}\left(\dfrac{1}{x}-\dfrac{1}{\sqrt{x^2+a^2}}\right)$

Correct

Part C

Calculate the *x*-component of the force that the charge distribution Q exerts on q.

Express your answer in terms of the variables Q, q, x, y, a and appropriate constants.

ANSWER:

$$F_x = -\frac{qQ}{4\pi\epsilon_0 x}\cdot\frac{1}{\sqrt{x^2+a^2}}$$

Correct

Part D

Calculate the *y*-component of the force that the charge distribution Q exerts on q.

Express your answer in terms of the variables Q, q, x, y, a and appropriate constants.

ANSWER:

$$F_y = \frac{qQ}{4\pi\epsilon_0 a}\left(\frac{1}{x}-\frac{1}{\sqrt{x^2+a^2}}\right)$$

Correct

Part E

Show that if $x \gg a, F_x \cong -Qq/4\pi\epsilon_0 x^2$ and $F_y \cong +Qqa/8\pi\epsilon_0 x^3$.

Essay answers are limited to about 500 words (3800 characters maximum, including spaces).

ANSWER:

My Answer:
Since x>>a Fy<<Fx so F=|Fx| = qQ/(4*pi*enot*x^2)

Problem 21.102

Two very large horizontal sheets are 4.25 cm apart and carry equal but opposite uniform surface charge densities of magnitude σ. You want to use these sheets to hold stationary in the region between them an oil droplet of mass 394 $\mu\mathrm{g}$ that carries an excess of five electrons. Assume that the drop is in vacuum.

Part A

Which way should the electric field between the plates point?

ANSWER:

- **field should point downward**
- **field should point upward**

Correct

Part B

What should σ be?

ANSWER:

σ = **42.7** $\mathrm{C/m^2}$

Correct

Score Summary:

Your score on this assignment is 97.9%.
You received 97.88 out of a possible total of 100 points.