CH217 - Homework

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Homework Assignment 1: General Chemistry Review (due 2/8/2010)

1. Get a General Chemistry text that you may use as a reference for the semester.
2. Complete the attached CH141 and CH142 exams (you may consult each other, but must submit your own work). Please turn in a hard copy in class.
   Ch142 Final 2000.pdf   CH141 Final Exam 2003.pdf

Homework Assignment 2: Room Energy Audit (due 2/15/2010)

Every student will help prepare a Colby student energy audit of electrical appliances used by the student body. Start by claiming an appliance by adding your name to the table below. You may fill in the rest of your row at a later date.

Name	**Appliance**	**Energy Consumption (J/year)**	**Number on Campus**	**Total Energy**
example	microwave	3.73 * 10^4 kJ/year	1077.1	4.01 * 10^7 kJ
Sarah	Cell chargers	1.45 *10^7 J/year	1764	2.56 *10^7kJ
Andy	Laptop chargers	4.60 E8 J/year	1867	8.59 E8 kJ
Reuben	Televisions	99600kj/female-yr; 24300kj/male-yr	960 female; 790 male	2.88 E8 kJ/yr
Erin	Hair Straighteners	1.96 * 10^7 J/year	966.7	3.45 *10^7 kJ
Rachael	Lamps	9.58 E7 J/yr	1717	1.65 E8 kJ
Amy	Refrigerators	2.7 * 10^8 J/year	600	1.62 * 10^9 kJ
Devon	Speakers	6.93 * 10^7 J/year	1235	8.56 * 10^7 kJ
Mike	Electric Razors	1.79 * 10^3 J/year	706	1.26 * 10^5 kJ
Kimberly	clocks	1.36 x 10^8 J/yr	752	2.4 x 10^8 kJ/yr
Greg	Coffee Maker	1.281 x 10^5 kJ/year	176.4	2.260 x 10^7 kJ/yr
Josie	Microwave	5.3 * 10^5 kJ/year	875	4.6 * 10^8 kJ
Trevor	Gaming Console			

Once you have selected the appliance, survey 10 or more rooms to get a statistical sampling of the appliance frequency on campus. Determine the energy consumed by the appliance over the course of the academic year and compute the total energy consumed by all students using the appliance. Put your data in the table above and provide the details on your appliance and your calculations below. This assignment is only submitted on this page.

Post answers to assignment 1 below: (list name, appliance, and then details)
Steve Jobs, Apple laptop computer

Details on the calculations for computer energy consumption ....

Example, Blow Drier

	Brand	Voltage (V)	Current (A)	Power (W)
1	Jilbere	125	10	1250
2	Physique	125	15	1875
3	Revlon	125	15	1875

4	Conair	125	15	1875
5	Perfection Classic	125	15	1875
6	Vidal Sassoon	125	15	1875
7	Conair	125	15	1875
8	Conair	125	15	1875
9	Conair	125	15	1875
10	Conair	125	15	1875
Average				1812.5

Average Energy Consuption a year assuming 10 minutes daily use.

1812.5 J/sec * 60 sec/min * 10 min/day * 365 day/year = 3.97E8 J

Assuming every female (54.8%) on campus and no males use a blow dryer (some guys have hair driers)

3.97E8 J * 1867 * 54.8% = 4.06E11 J = 4.06E8 kJ

Electric Razors

Sample #	Brand	Use (min/week)	Voltage (J/c)	Current (c/sec)	Power (J/sec)
1	Braun	10	12	0.400	4.8
2	Braun	12	12	0.400	4.8
3	No Razor				
4	No Razor				
5	No Razor				
6	Phillips Norelco	7	15	0.420	6.3
7	Phillips Norelco	12	15	0.420	6.3
8	No razor				
9	No razor				
10	No razor				
Average	40% of student body	10.25			5.6

Average Energy Consumption:

5.6 J/sec * 60 sec/min * 10.25 min/week * 52 weeks/year = 1.79 * 10^3 J/year

Assuming only males use electric shavers

1.79 * 10^3 J/razor/year * 1764 students * 0.40 razors/student * 1J/1000kJ = 1.26 * 10^5 kJ/year

Devon McIntyre, iPod/Computer Speakers

Sample #	Brand	Voltage (V)	Current (A)	Power (W)
1	Altec Lansing, InMotion	100 - 240	0.8	80
2	Logitech	120	0.525	63
3	Bose	120	0.16	19.2

4	Bose	120	0.16	19.2
5	JBL	120	0.183	22
6	JBL	120	0.183	22
7	JBL	120	0.183	22
8	Klipsch	100 - 240	max 1.5	150
9	iSymphony	120	0.9	108
10	JBL	120	0.183	22
Average				52.74

Average energy consumption in a year assuming speakers are used 1 hour per day:

52.74 J/sec * 60 sec/1 min * 60 min/1 day * 365 days/1 year = 6.93 E7 J/year

Colby students total – 1838

% Colby students on campus – 96%

Total Colby students on campus – 1764

Assume 70% of students have speakers – 1764 * .70 = 1235 students with speakers on campus

1235* * * 6.93 E7 J = 8.56 E10 J = **8.56 E7 kJ/year**

Rachael Mack: Lamps

	Brand	Voltage (V)	Current (A)	Power (W)
1	Walmart	120	0.5	60
2		120	0.33	40
3	Your Zone	120	0.33	(40*5 bulbs) 200W
4		120	0.33	40
5	Jansjo	120	0.09	10.8
6	Jansjo	100	0.09	0.09
7	Walmart	120	0.12	14
8		120	0.5	60
9		120	0.33	40
10	Walmart	120	0.12	14
Average				48.78

Assuming there is on average one lamp per person, and each person uses it daily for about 1.5 hours. (Approximately 93% of the total student body lives on campus – 1717 students.)

48.78 J/s * 60 s/min * 90 min/day * 365 day/yr = 9.61 E7 J/yr

9.61 E7 J/yr * 1717 students = 1.65 E8 kJ/yr

Reuben Biel, Television

Room No	Brand	Volt (V)	Current (A)	Wattage (W)	Time (hrs_used/ day)	Occupants	Gender	kJ Used per Room per Day	kJ Used per Individual per Day
1	Sylvania	120	0.44	53	0.57	3	M	109.0285714	36.34285714
2	Emerson	120	0.5	60	1	2	F	216	108
3	---	0	0	0	0	2	M	0	0
4	Orion	120	0.92	110	1	2	F	396	198
5	Olevin	120	1	100	1.5	3	M	540	180
6	---	0	0	0	0	2	F	0	0
7	---	0	0	0	0	3	M	0	0
8	Emerson	120	0.46	55	1	2	F	198	99
9	Magnavox	120	2	240	0.57	1	M	493.7142857	493.7142857
10	Magnavox	120	0.33	40	5	1	M	720	720
11	RCA	120	0.46	55	1.5	1	F	297	297
12	LG	120	1.25	150	6	1	M	3240	3240
13	Insignia	120	0.58	70	0.5	0.5	F	126	---
13A	LG	120	1.25	150	2	0.5	F	1080	---
13 Total		0	0	0	0	1	F	0	1206
14	---	0	0	0	0	1	F	0	0

Assuming that Televisions only draw energy while being used (false assumption so is an underestimate of actual usage):
Average Usage per Female per Day (including those without TVs): 273 kJ/day
Average Usage per Male per Day (including those without TVs): 667 kJ/day
If there are approx. 960 females (54.8%) and 790 males on campus (Total 1750 students), then:
Total Female Usage per Year = 273 kJ/female-day*365 days/yr*960 females = 9.55E7kJ/yr
Total Male Usage per Year = 667 kJ/male-day*365 days/yr*790 males = 1.92E8kJ/yr
Total Energy Usage per Year = 9.55E7kJ/yr + 1.92E8kJ/yr = **2.88E8kJ/yr**

Kimberly Bittler, Electric alarm/radio clocks

| **Room** | **Brand** | **Voltage (V)** | **Current (A)** | **Power (W)** |

1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	Timex	120	0.05	6
5	Memorex	15	1	15
6	Sony	120	0.04	5
6	0	0	0	0
6	0	0	0	0

7	Sony	120	0.04	5	
8	RCA	22	1	22	
8	iPod	15	1.5	22.5	
9	0	0	0	0	
9	0	0	0	0	
9	0	0	0	0	
10	0	0	0	0	
11	0	0	0	0	
12	Sony	120	0.04	5	
13	0	0	0	0	
14	Sony	120	0.04	5	
15	Memorex	120	0.04	5	
16	0	0	0	0	

Number of students with alarm clocks:

9/21 students in the survey = 43 % x ~1750 students on campus = 752 students

Average power use of alarm clocks: 10.0 W

Total Average power use (including non-owners): 4.3 W

Yearly Average Power Use per student:

4.3 J/sec x 60 sec/min x 60 min/hr x 24 hr/day x 365 day/yr = 1.36 x 10^8 J/yr

Campus Power use:

1.36 x 10^8 J/yr x 1750 students = 2.40 x 10^11 J/yr x 1 kJ/1000 J **= 2.40 x 10^8 kJ/yr**

Josie Thiele, Microwave Oven

	Brand	Voltage (V)	Current (A)	Power (W)
1	Cuisinart	120	8	1000
2		120	8	1000
3	GE	120	9	1100
4		120	9	1100
5	LG	120	13	1500
6		120	13	1500
7		120	13	1500
8	Sharp	120	9	1100
9		120	9	1100
10	Frigidaire	150	6	900
Average				1180

Assuming that there is one microwave per room (and each room has 2 people in it), and each room uses it for 20 minutes a day.

Yearly Average Power Use per microwave

1180J/s*60s/min*20min/day*365day/yr*1kJ/1000J=5.2*10^5kJ/yr

Annual Campus Power Use

Assuming there is one per room, ~875 rooms

5.2*10^5kJ*875rooms=4.6*10^8kJ/yr

*Erin Schnettler-Hair Straightners

Sample	Brand	Voltage (V)	Power (W)
1	Emperor	110V	200W
2	Solia	110V	58W
3	Sedu	110V	72W
4	Solia	110V	58W
5	CHI	110V	35W
6	Sedu	110V	72W
7	Conair	120V	36W
8	Solia	110V	58W
9	Hot Tools	110V	170W
10	Solano	110V	135W
Avg.	**89.4W**		

--Average Energy Consumption per year assuming 10 minutes of daily use
89.4J/sec*(60sec/min)**(10min/day)**(365days/year)=19578600 J/year

--Avg. Energy Consumption per year assuming that use is limited to all females on campus:
19578600 J * 1,764 students * .548 =3.454*10^10 J (1 kJ/1000 J) = 3.45*10^7 kJ/year

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Greg Klein: Coffee Makers

	Brand	Voltage (V)	Current (A)	Power (W)
1	Mr. Coffee	120	7.5	900
2		120	7.5	900
3	Black and Decker	120	10	1200
4	Cuisinart	120	13.833	1660
5		120	13.833	1660
6	Cuisinart	120	9.166	1100
7		120	9.166	1100
8	Hamilton Beach	120	7.5	900
9	Hamilton Beach	120	12	1140
10		120	12	1140
Average	**1812.5**			

Assuming about one in ten students has a coffee maker:

0.1 x 1764 students = 176.4 students

Average yearly power consumption, assuming 5 minutes daily use:

1170 J / sec x 60 sec / min * 5 min x 365 = 1.281 x 10^8 J / year

Total power consumption for the campus:

1.281 x 10^8 (J / year x students) x 176.4 students = 2.260 x 10^10 J / year

2.260 x 10^7 kJ / year

Andy Oakes, Laptop Chargers

-->| Sample | Brand | Voltage | Current | Power |

1	Macbook	16.5V	3.65A	60W
2	Macbook Pro	16.5V	3.65A	60W
3	Dell Latitude	19.5V	3.34A	65W
4	Dell Inspiron	19.5V	3.34A	65W
5	Macbook Pro	16.5V	4.6A	85W
6	HP Compaq	19V	4.74A	90W
7	Macbook Pro	16.5V	3.65A	60W
8	Macbook	16.5V	3.65A	60W
9	Dell Inspiron	19.5V	3.34A	65W
10	Gateway NV	19V	4.74A	90W
Average				70W

Average Energy Consuption a year assuming 300 minutes daily use.

70 J/sec * 60 sec/min * 300 min/day * 365 day/year = 4.60E8 J/year

Assuming everyone on campus has a laptop

4.60E8 J * 1867 = 8.59E11 J = 8.59E8 kJ

Sarah Dallas-- Cell Phone Chargers

sample	brand	voltage (V)	current (A)	Power (W)
1	LG	5	1	5
2	BlackBerry	5	0.7	3.5
3	BlackBerry	5	0.7	3.5
4	Samsung	5	0.7	3.5
5	LG	5.1	0.7	3.57
6	LG	5.1	0.7	3.57
7	Motorola	5	0.55	2.75
8	LG	4.8	0.9	4.32

9	LG	5.1	0.7	3.57
10	BlackBerry	5	0.7	3.5
Average				3.678

1764 chargers on campus, because every student has a cell phone

Assume they are used by everyone for 3 hours a day every day of the year

3.678 J/sec * 60 sec/min * 60 min/hr * 3 hr/day * 365 days/yr = **1.45E7 J/yr**

Power*#of chargers >> 1.45E7 * 1764 = 2.56E10 J >> **2.56E7 kJ**

Trevor Poole - Game Consoles

Sample #	Brand	Use (min/week)	Voltage (V)	Current (A)	Power (W)
1	Xbox 360	120	12	12.1	150
2	None	0	0	0	0
3	None	0	0	0	0
4	Xbox 360	60	12	14.2	175
5	None				
6	Wii	90	12	3.7	33
7	None	0	0	0	0
8	Xbox 360	90	12	14.2	175
9	Wii	90	12	3.70	33
10	None				

40% of rooms total have game consoles, however all surveyed were male. 1764 total students * (.4 (males on campus) * .5 (males with game consoles)) =.2 total, or 353 game consoles on campus

Used for an average of 90 minutes per day

113.2J/s * 60seconds/minute * 60 mins/hour * 1.5 hours/ day * 365 days/year = 223,117.2 kJ per year per console.

223,117.2 kJ * 353 consoles = 78,760,371.6 kJ

Amy Holmen, mini fridges

Sample	Brand	Votage (V)	Current (A)	Power (W)
1	GE	120	0.75	90
2	MagicChef	115	1.2	138
3	MagicChef	115	1.3	149
4	Sanyo	120	1.0	120
5	Haier	110	1.1	121
6	Danby	120	0.85	102
7	none	--	--	--
8	GE	120	0.75	90

9	none	--	--	--
10	MagicChef	115	1.2	138
			AVERAGE	118.5

Yearly Average power use per fridge

Let us assume that the fridge is plugged in and running all day for 9 months of the year (our school year)

118.5 J/sec * 60 sec/1 min * 60 min/1hr * 24 hr/day * 270 day/year= 2.7 *10^6 kJ per year per fridge

Annual Campus Power Use

Assume that 80% of rooms have a fridge, so 750 rooms * 0.80= 600 fridges on campus

2.7*10^6 kJ/year/fridge * 600 fridges= 1.62*10^9 kJ/year

Homework 3- The basics of biomass (due 2/26/2010)

Some Links to get things started

http://blogs.middlebury.edu/biomass/

http://www.colgate.edu/DesktopDefault1.aspx?tabid=4354

http://www.fs.fed.us/woodybiomass/state.shtml

biomass_memo_071708.pdf

tb197.pdf

http://www.aashe.org/wiki/climate-planning-guide/carbon-offsets.php

http://alethonews.wordpress.com/2010/01/12/up-in-smoke/

Questions to consider:

1) It is generally assumed that Maine is harvesting wood at a rate equal to the annual growth rate.   Is this true? What are Maine's requirements for sustainable growth?

2) If question one is true, how does a biomass plant meet the additionally principle for carbon neutrality? Do we have additional biomass capacity in Maine?

3) Using Middlebury's wood consumption as a guide, how many acres of forest are required to meet the fuel requirements of the proposed biomass plant at Colby? How many acres of forest will need to be harvested to meet Colby's fuels supply in a sustainable fashion?

A) Divide the class into groups of four and decide which group will address which question.

B) Starting with the resources provided at the beginning of this question, generate an annotated bibliography of sources to help answer your question.

C) Generate two figures diagramming the material flows used to help answer your question.

D) For class on Friday, 2/26.   Be prepared to present your two figures and your strategy for answering your group question.

Works Cited

Gibbs, Jeff. "Green Nightmare: Burning Biomass is Not Renewable Energy." *The Huffington Post*. 17 Dec. 2009. Web. 23 Feb. 2010. <http://www.huffingtonpost.com/jeff-gibbs/green-nightmare-burning-b_b_395553.html>.

The Gibb's article gives an opposing view, explaining why biomass generated energy is not a renewable energy source.

MaineForest Service. MaineForest *Service Assessment of Sustainable Biomass Availability*. Rep. Maine State Government, 17 July 2008. Web. 24 Feb. 2010. <http://www.maine.gov/doc/mfs/pubs/pdf/biomass_memo_071708.pdf>.

The Maine Forest Service Report provided information regarding the current biomass of Maine's forests, and the sustainable yield for the forests.

MiddleburyCollege. "Biomass at Middlebury." *The Middlebury Blog Network*. Web. 24 Feb. 2010. <http://blogs.middlebury.edu/biomass/about/>.

The Middlebury site was used to obtain general as well as specific information regarding the use of biomass technology at MiddleburyCollege. This information was used to determine what would be necessary for Colby to use biomass technology.

National Alliance of Forest Owners. "Carbon Neutrality of Energy from Forest Biomass." *Carbon Neutrality of Energy from* Forest Biomass. NAFO (National Alliance of Forest Owners), 2009. Web. 23 Feb. 2010. <http://nafoalliance.org/carbon-neutrality-of-energy-from-forest-biomass/>.

The National Alliance of Forest Owners site provides background information in regards to the carbon neutrality of producing energy from forest biomass.

Sarah, Kim, Reuben, and Trevor

Homework 4 - Due 3/5/2010

Book Problems - Chapter 9: 4, 6, 9, 12, 13

Additional Problems

1. Freon, CFC-12, is building up in the atmosphere at a rate of 1.4 %/year. If the current concentration of CFC-12 is 519 pptv (parts per trillion by volume), what is the net molar flux of CFC-12 to the atmosphere in one year?

2. Calculate the maximum wavelength of radiation that could have sufficient energy to effect the dissociation of nitric oxide (NO). In what regions of the atmosphere would such radiation be available? (The bond energy of NO is 90.2 kJ/mol)

3. The Chapman mechanism of stratospheric ozone production was successful at predicting the shape of the stratospheric ozone concentration profile, but overestimated the ozone concentration. We now understand that simple ozone models involving only O_2, O and O_3species are incomplete. What are the major processes controlling the stratospheric ozone concentration profile (shape and concentration) and how have atmospheric emissions in the last 50 years modified the profile. (HW Key)

Homework 5 - Due 4/7/2010

Book Problems **11:** 2, 7, 9, 14, **13**: 4, 7, 11,17

Additional Problem: During a recent talk at the Maine Water Quality Conference, Professor Steve Kahl from UMO showed convincing evidence of decreased acid deposition to Maine based on decreasing sulfate concentrations in Maine lakes. During the same 10 year period the nitrate concentrations have also decreased, but much more slowly. Explain these findings in terms of the chemistry of “acid rain” including current regulations, atmospheric chemistry, and emission sources.

Homework 6 - Due 4/16/2010

Lake Problem Set I.

Consider a lake of infinite horizontal dimension, a depth of 20 meters, and a thermoclineat 10 meters. The epilimnetic temperature is 25 ^{o}C. The hypolimnetic temperature is 6^{o}C. Both layers are well mixed vertically. The alkalinity of the lake is 0.10 mM.

1) Calculate the equilibrium concentration of oxygen at depths of 5 and 15 meters in units of ppm and moles/liter.

2) If the average wind speed on the lake is 10 meters/second, what rate of net biological oxygen demand (moles/liter sec) is required to decrease the oxygen concentration to 90% of saturation at 5 meters?

3) Based on the biological oxygen demand, how long will it take the hypolimnion to go anoxic (<1 ppm O2)?

Key: Lake problem 2010 O2 solubility.xls

Homework 7 - Due 4/23/2010

Lake Problem Set II.

Consider a lake of infinite horizontal dimension, a depth of 20 meters, and a thermocline at 10 meters. The epilimnetic temperature is 25 ^{o}C. The hypolimnetic temperature is 6^{o} C. Both layers are well mixed vertically. The alkalinity of the lake is 0.10 mM.

1) Calculate the pH of the epilimnion assuming it is in equilibrium with CO_2 in the atmosphere.

2) Assuming that the phosphate concentration of the lake was 20 ppb (as P) at the time of the spring turnover, calculate the oxygen concentration in the lake at 5 meters and 15 meters after all the P in the epilimnion is consumed by photosynthesis, settles, and is respired in the hypolimnion.

3) What is the pH of the hypolimnion after the event described in step 2 occurs?

4) By how much will the nitrate in the hypolimnion increase after the event described in step 2 occurs?