The Carbon Cycle – Students Help to Control Their Carbon Footprint

Category
Science, Mathematics, Reading

Materials
Data Tables and Template for Personal Data (Included)

Real World Connection
Research, Future Planning, Commerce, Climate, Transportation

Problem Questions

How much energy is used by appliances on stand-by mode?

How can a student help to control greenhouse gas emissions?

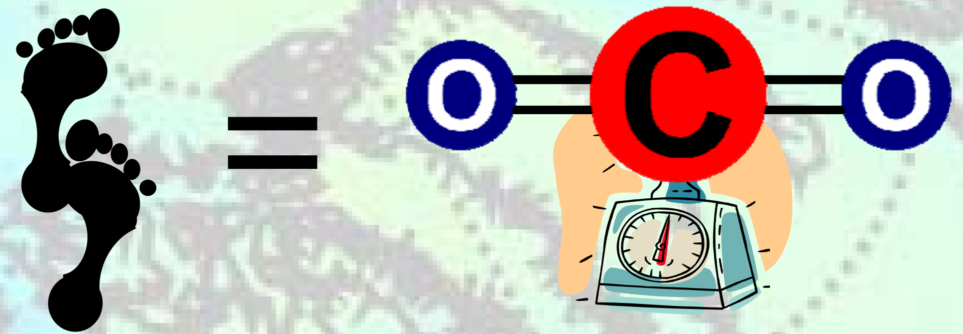
Prior Knowledge What I Know Based on your prior knowledge, answer the problem question to the best of your ability.	Conclusion What I Learned Answer the problem question after completing the activity.
1.	1.
2.	2.

Background - Introduction

Every time you turn on a light, get in a car to run an errand, or take a plane on vacation, do you think about how much carbon you are adding to the atmosphere?

Probably not.

Yet, whenever you use a fossil fuel, you leave a carbon dioxide "footprint" upsetting the natural rhythm of the carbon cycle.



Carbon Footprint **is** ***The amount of CO_2 released into the atmosphere by burning fossil fuels***

Fossil fuels - coal, natural gas, and oil - provide the energy that we depend upon for our comfortable standard of living. For example, most electricity is produced by burning coal; and, both gasoline for our cars and jet fuel are made from oil. Whenever you use a fossil fuel, you leave a carbon dioxide "footprint" upsetting the natural rhythm of the carbon cycle.

Background – Student Activities

Between 1961 and 2007, in about a half century, the average amount (concentration) of carbon dioxide (CO_2) in the Earth's atmosphere has increased from 317 parts per million (ppm) to 384 ppm.

What percent increase is this?

Let's do the math!

First, subtract to find the difference.

384
-317
67 ppm

Now, divide this difference by the beginning CO_2 concentration.

67 divided by 317 (67/317) = 0.21

Last, move the decimal two places to the right for a percent (the same as multiplying by 100).

21% increase in carbon dioxide in the Earth's atmosphere from 1961 to 2007

In the space that follows, calculate the percent CO_2 concentration increase between 1914 and 1960.

1914 CO_2 concentration = 301 ppm
1960 CO_2 concentration = 316 ppm

Compare and contrast: Which half century has the highest percent increase of CO_2?

How many times greater is the percent of CO_2 increase?

FYI

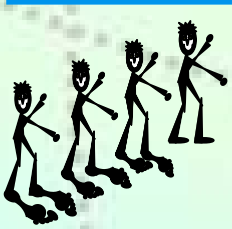
384 parts per million (ppm) means that, for every one million (1,000,000) molecules of dry air in our atmosphere (oxygen, nitrogen, argon, and many minor gases), 384 of those molecules are carbon dioxide. Parts per million is a standard method to measure concentration of a particular element in a mixture of elements.

Background – Student Activities (Continued)

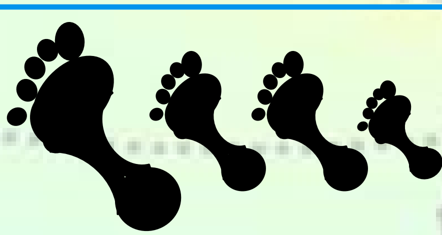
Fossil fuels not only provide energy, but serve as the raw material for thousands of consumer products. Listed in the following table are examples of these products.

1. Study the list, then add at least one example from your experience.
2. Check-off (✓) those that you might give-up to reduce your carbon footprint.

Category	Example	Student Examples	Check-Off
Fuels	Gasoline, Electricity, Jet Fuel		
Plastics	Furniture, Computer Parts, Toothbrushes, Plexiglass, Contact Lenses, Sunglasses		
Fabric	Nylon, Synthetic Fabrics		
Floors	Tile		
Medications	Pepto-Bismol, Vaseline		
Household	Detergents, Paints, Waxes, Solvents, Weed Killer		
Make-Up	Lip Gloss, Hair Spray, Hair Coloring		
Toys	Stuffed Animals		
Source: Illinois Department of Natural Resources (http://www.ioga.com/Special/PetroProducts.htm)			



Reduce Your Carbon Footprint!



Students, joining together to reduce carbon emissions, can make a difference!

Background - Student Activities (Continued)

Reduce Your Personal Carbon Footprint

How can one person, especially a student like you, reduce your carbon footprint to help control greenhouse gas emissions? Do you know how much carbon dioxide you contribute to our atmosphere? Probably more than you might guess.

For example, many people think of electricity as a clean source of energy, but most electrical power in the U.S. is produced by burning coal, a fossil fuel.

Suppose you keep a 100 watt light bulb on as a night light for eight hours a day, 365 days a year, and each kilowatt hour (kWh) of electricity requires burning 1.37 pounds of coal, you contribute 500 pounds of CO_2 per year.

One light bulb does not sound like much, but if every person in the U.S. joined the effort, that would be 100 million households x 500 pounds of CO_2 = 50,000,000,000 pounds (fifty trillion). Now that is impressive!

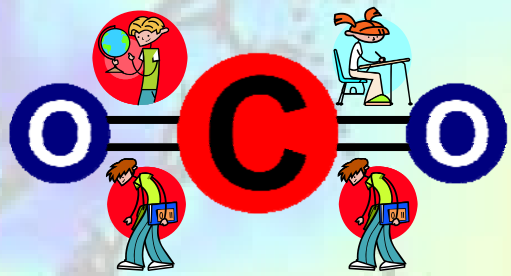
What Can Each of Us Do to Reduce Our Own CO_2 Footprint?

The answer should be obvious...

Reduce the amount of energy that we use.

How?

1. **At home use less electric power, heating and air conditioning.**
2. **For transportation, ride a bike, walk, carpool, or use public transportation!**
3. **Reduce air travel.**



You will notice that some uses of fossil fuels, like heating and cooling your home and air travel, are not included in this activity. We want you, as a student, to concentrate on what you can do to reduce your carbon footprint in one area of energy use that you have direct control over...

Electricity!

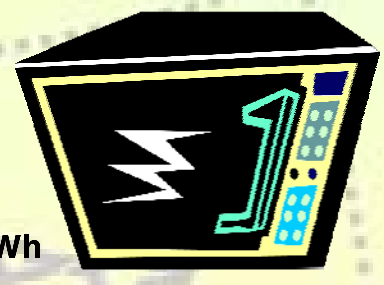
Each and every student in the United States controls an amazingly large amount of carbon. Therefore, you have the power to make a big difference!

No need to wait...

Take Action!

For Example

A microwave oven has a 1500 Watt rating, that is used for one half hour each day.



If ... **kWh =** $\frac{W \times h}{1000}$

Then ... $\frac{1500 \times 0.5}{1000}$ = **0.75 kWh**

Now ... **Cost = kWh x cost per kWh**

Note ... The local power company charges $0.10 (10 cents) per kilowatt-hour.

So ... 0.75 kWh x $0.10 = **$0.075 per day (round off to $0.08 per day)**

Thus ... $0.08 x 7 days per week = **$0.56 per week**

And ... $0.56 x 52 weeks per year = **$29.12 per year**

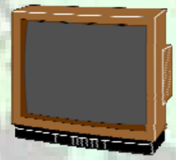
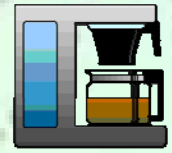
Procedure – Part 1

Have you ever suspected that some appliances "leak" electricity?

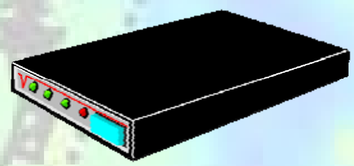
Some do!

Appliances that have a remote control need electric power and function with a "stand-by" option.








Compare and contrast the rate of using electricity for both the “on” and “stand-by” operations. Use the directions in the steps that follow. Use the data in the table at the bottom of this page to draw a **bar graph** on Page 14-6 (Figure 14-1) of this activity.

1. On the x-axis of the grid, for each appliance, draw two bars side-by- side, one for "on" and one for "stand-by". For numbers greater than 100, write the actual number on the top of its bar.
2. On the y-axis, number the amount of energy used in Watts.
3. Label both axes and write a title for your graph.
4. Make a color key for the bars: one color for "on" and different color for "stand-by".

Although the data are approximate, there is enough information to compare the energy needed to operate appliances both while "on" and on "stand-by". Assume that the “stand-by” mode is off when the appliance is “on”.

From UPPCO and Directgov - UK

Typical Electricity Use Per Appliance

(The typical rate of energy use, in watts, by appliances on “stand-by” compared to “on”, for one day.)

Appliance	Standby	On
Answering Machine	3	3
Clock Radio	2	10
Computer	50	270
Microwave	3	1500
Mobile Phone Charger	1	5
VCR	5	19
Stereo	12	22
Broadband Modem	14	14
DVD Player	7	12
Television	10	100
Total (Students – Find the Totals)		

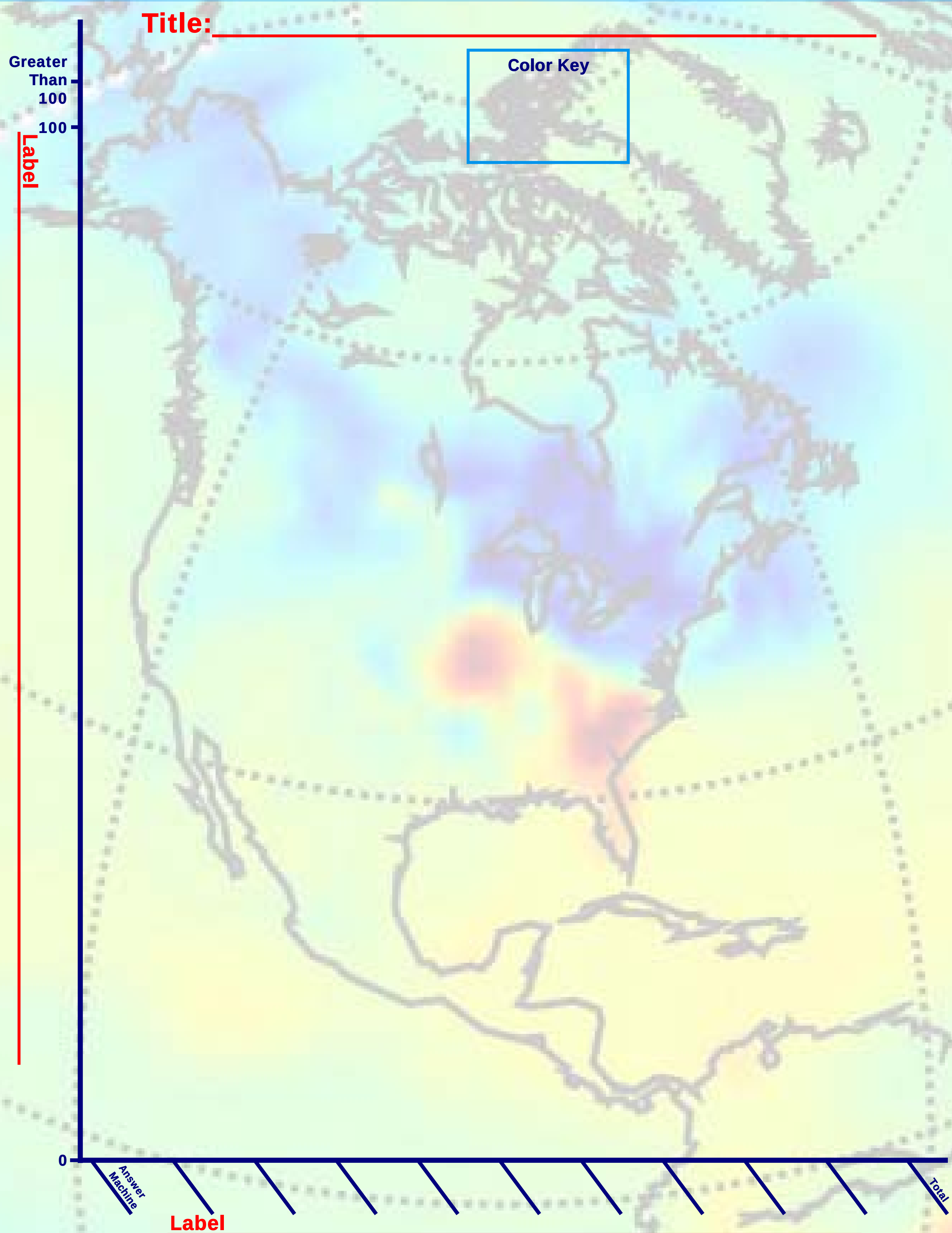

Title:
Color Key
Greater Than 100
100
Label
0
Answer Machine
Total
Label

Figure 14-1.

Questions – Part 1

1. What appliance uses the most power while fully operating? What appliance uses the most power while on "stand-by? Does this make sense? Explain.

2. If all of the appliances were used in one day for the typical amount of time, find the total number of Watts for “stand-by”, then find the total for “on”.

3. Find the number of kilowatt hours of electricity used to continuously operate the appliances for one day. (Refer to the table on page 14-5.) (Hint: When “on”, appliances do no use “stand-by” energy.)

4. What percent of the total amount of electricity used in one day is the “stand-by” total?

5. If your local power company charges ten cents per kilowatt hour, calculate the cost for using only the “stand-by” function for one day. For one week. For one year. (Note that Cost = kWh x 0.10.)

6. Which appliance surprised you by its power use? Why?

Procedure – Part 2

By keeping track of the amount of time that you use each electrical appliance, you can calculate approximately how much CO_2 that you add to Earth's atmosphere as a result of using these appliances.

In other words...

you can calculate part of your carbon footprint.

Planning to Collect Data Based on your Personal Electric Appliance Use

Begin by collecting baseline data for future comparison. Without changing your life style, keep a record of the amount of electricity that you use for **two days**.

For the **next two days** do your best to contribute as little CO_2 as possible.

Leave blank the row for appliances that you do not use. Add appliances on the blank lines that you use, but are not on the list.

Then, create a plan for the future, based on your personal data.

1. Set a goal to reduce your use of electricity.
2. List the actions that you will take.

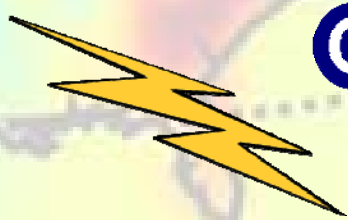
How to Fill-In the Data Tables to Calculate Part of your Personal Carbon Footprint

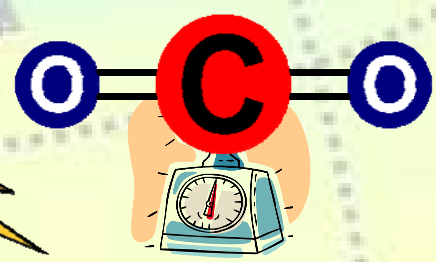
As you read these instructions, refer to the steps in the sample table at the bottom of this page.

Under the heading "h“ (Hrs), enter the number of hours that each appliance is used. For a fraction of an hour, let each minute equal **0.02 hrs**.

On a separate sheet of paper, calculate the number of kilowatt hours that you use each appliance per day, and enter the results. Then, find the number of kilowatt hours for a week and for a year. Enter your results.

On a separate sheet of paper, calculate the approximate amount of carbon that is contributed to Earth's atmosphere by operating each appliance. Enter that number under pounds CO_2.





Sample Data

Follow the directions, using Steps 1 – 6 in this table, to calculate the approximate amount of CO_2 that you contribute to our atmosphere in two days and one year. Fill in the tables on Pages 14-9 and 14-10 with your answers. Use the back of these pages to write out your calculations. Use extra paper if you need it.

Appliance	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
	Number of Watts the Appliance Uses While “On” - (W)	Number of Hours While “On” - (h)	Number of Kilowatt Hours (kWh) of Power Used per Day	Number of Kilowatt Hours of Power Used per 2 Days of the Activity	The Average Amount of CO_2 Produced for 1 kWh of Power is 1.37 pounds (lbs)	Pounds (lbs) CO_2 Produced per Year
			$\frac{W \times h}{1000}$ = kWh	$\frac{kWh}{Day} \times 2 = \frac{kWh}{2\ Days}$	$\frac{kWh}{2\ days} \times \frac{1.37\ lbs}{kWh}$	$\frac{lbs}{2\ Days} \times \frac{365\ Days}{Year}$
Example:	Example:	Example:	Example:	Example:	Example:	Example:
A 100 Watt Light Bulb	100 Watts	8 Hours	$\frac{100 \times 8}{1000} = 0.8$	0.8 x 2 = 1.6 kWh per 2 days	1.6 x 1.37 = 2.2 lbs CO_2 per 2 Days	$\frac{2.2 \times 365}{2}$ = 401.5 lbs CO_2 per Year

Procedure – Part 2 (Continued)

Current Use		Day 1			Day 2			Two-Day Total		
Appliance	**Watts**	Hrs	kWh	lbs. CO_2	Hrs	kWh	lbs. CO_2	Hrs	kWh	lbs. CO_2
Answering Machine On	3									
Answering Machine Standby	3									
Broadband Modem On	14									
Broadband Modem Standby	14									
Clock Radio On	10									
Clock Radio Standby	2									
Computer On	270									
Computer Standby	50									
DVD Player On	12									
DVD Player Standby	7									
Hair Dryer	1500									
Lightbulb 100 Watts	100									
Lightbulb 60 Watts	60									
Lightbulb 40 Watts	40									
Microwave On	1500									
Microwave Standby	3									
Cordless Phone Charger On	5									
Cordless Phone Charger Standby	1									
Stereo On	22									
Stereo Standby	12									
Toaster	1100									
TV On	100									
TV Standby	10									
VCR On	19									
VCR Standby	5									
Video Game	79									
Total Amount of CO_2 in lbs										
Total Amount of CO_2 in kg										

Use this side for your calculations for Page 14-9.

Procedure – Part 2 (Continued)

Reducing Your Footprint		Day 3			Day 4			Two-Day Total		
Appliance	Watts	Hrs	kWh	lbs. CO_2	Hrs	kWh	lbs. CO_2	Hrs	kWh	lbs. CO_2
Answering Machine On	3									
Answering Machine Standby	3									
Broadband Modem On	14									
Broadband Modem Standby	14									
Clock Radio On	10									
Clock Radio Standby	2									
Computer On	270									
Computer Standby	50									
DVD Player On	12									
DVD Player Standby	7									
Hair Dryer	1500									
Lightbulb 100 Watts	100									
Lightbulb 60 Watts	60									
Lightbulb 40 Watts	40									
Microwave On	1500									
Microwave Standby	3									
Cordless Phone Charger On	5									
Cordless Phone Charger Standby	1									
Stereo On	22									
Stereo Standby	12									
Toaster	1100									
TV On	100									
TV Standby	10									
VCR On	19									
VCR Standby	5									
Video Game	79									
Total Amount of CO_2 in lbs										
Total Amount of CO_2 in kg										

Use this side for your calculations for Page 14-10.

Questions – Part 2

1. Which appliance(s) uses the most electricity?

2. For the appliance(s) that used the most electricity in one day, how many pounds of CO_2 would be produced per year?

3. Calculate the total amount of CO_2 that you produced per year by using all of the appliances in your data tables.

4. Combine appliance use and stand-by use to calculate your personal electric energy cost.

5. List strategies to reduce your carbon foot print.

6. Using SI units (Meter, Liter, Gram), calculate the mass (weight) of CO_2 that you contributed in one week. In one year. (Note: One pound [lb] = 0.45 kilograms [kg])

Questions – Part 2 (Continued)

7. To estimate your total footprint, fill in the following table.

Energy Source	Average CO_2 Emission	Personal Number of Units	Estimate of Personal CO_2 Footprint (lbs)	Estimate of Personal CO_2 Footprint (kg)
Electricity	1.37 lbs CO_2 per Hour	______ Hours		
Natural Gas	11 lbs per Cubic Foot	______ Cubic Feet		
Waste	2.2 lbs per day (Based on 0.4 lbs per day for two people)	______ per Person		
Auto Transportation	20 lbs per Gallon	______ per Gallon		
Air Travel	0.424 lbs per Mile Flown	______ per Air Mile		

<u>Use this space and extra paper if need for your calculations.</u>