2016-01 (Winter) - Physics NYB - Electricity and Magnetism - Greg Mulcair

Project

Objective

This project counts for 5% of your grade in this course. The objective is to help you gain familiarity with everyday electronic circuits like the ones throughout your home, to understand their limitations and to see why we have breaker boxes which can stop those circuits if needed.

Part 1: Home circuit investigation

Due date: Sunday, March 13th, before midnight
Done by: Each student individually (no groups)
Submit your work: Through the Moodle forum (details below)

Step 1:

Take a photo of the breaker box in your home/condo (if this is not possible, take one from the home of a friend or family member). Here is how it should look (source: Wikipedia article on Distribution Boards)

Step 2:

Each circuit breaker (black switch) controls one circuit in your home, and the name of the area/room for that circuit is usually clearly identified (e.g. kitchen, bedroom 1, bedroom 2, etc...). Take note of all the different rooms/areas that are listed (you will use these later).

Step 3:

Choose one area/room from your home (for example: Kitchen), and choose one electrical device that would typically be plugged there (for example: Toaster).

Log into Moodle and visit the Project forum. Look at the posts that your classmates have posted. If someone has already posted the same device that you want to post, you need to find a different one.

Take a photo of that electrical device, and take a photo of the "power rating" that should be inscribed on it. For example:

Step 4:

Draw a simple circuit diagram for when that one device is plugged in. There should only be two elements to your circuit (the 120 V power supply and the device you selected). Calculate the current passing through the circuit when the device is being used. Remember that since you know the power the device will demand (P) and you know the voltage it will be provided (V) you can easily use the power equation to find the current that will be drawn.

Step 5:

Refresh this page and look at the posts that your classmates have posted at the bottom of this page. If someone has already posted the same device that you want to post, you need to start over and find an original one.

Once you have an original device, create a new post by clicking the **Add a new discussion topic** button at the bottom of this page. (Note: When you click the button, the whole page reloads so you will need to scroll back to the bottom of the page).

The **Subject** of your post should be "*Room Name - Device Name*" where you replace *Room Name* with whatever room/area you have chosen, and you replace *Device Name* with whatever device you have chosen.

In the actual **Message** part of your post, start by typing out all the rooms/areas that have breakers as a bulleted list. For example:

- Kitchen
- Bedroom 1
- Etc...

Upload the photo of your breaker box.

Upload the photo of your device and it's power rating.

Upload the photo of your circuit diagram including the calculation of the current through the circuit.

Publish your forum post.

Part 2: Check your group members' circuits

Due date: Wednesday, March 16th, before class
Done by: Each student individually (no groups)
Submit your work: Through the Moodle forum (details below)

Step 1:

Click the following link to find what "Group room name" you have been assigned and who is in your room (these are your teammates for the rest of this project):

- Morning class, click here
- Afternoon class, click here

Step 2:

Open each of your teammates' forum posts in the Moodle Project forum. Read their post, analyse their circuit (compare with the power rating on the sticker of their device) and make any corrections by posting a "Reply" to their post. If there are no corrections to make and everything looks good, you can simply reply "Everything looks good!". But you must submit a reply to each of your teammates' posts.

Part 3: In-class work with SMART amp

Due date: Wednesday, March 16th, end of class
Done by: Groups
Submit your work: Through SMART amp (details below)

The following steps will be explained in class before we do the activity, and you will be given an instruction handout with screenshots.

Step 1: Come to class with a tablet or laptop

Step 2: Sit in your groups. Move desks around to be comfortably sit to collaborate together.

Step 3: Log in to SMART amp by visiting www.smartamp.com.

Step 4: Open the "Home Circuit" worksheet for our class. From the left-hand menu, choose the "Bookmarks" icon and click the bookmark that has your room name. This will zoom you into one of the 11 spaces available to build the circuit for your room.

Step 5: Type your room name and student first names below the area for your circuit.

Step 6: Draw your home circuit and calculate the current it uses when all devices are turned on.

Step 7: The current limit for a typical home wire is 20 A. If your circuit's total current exceeds that when all devices are on, choose the maximum number of devices that can be on at any moment, and now re-calculate the current your circuit uses.

Step 8: As a class, we will build the home circuit and discuss the total current and total power used, as well as how the metre measures this in kWh.

Part 4: Investigation into possibility of living off-grid

Due date: Monday, April 25th, start of class
Done by: Groups (same groups as part 3)
Submit your work: In class as one printed report per group (≈3-4 pages single spaced)

For this final part of the project, your group will submit a printed report consisting of the following:

Section 1: Home energy analysis (≈1.5-2 pages single-spaced)

For this part of the report, I want you to complete the table below. To do this, each student will need to write a few sentences of explanation and calculations, which must be included so that I understand how you got the numbers in your table. Hint: Consider using Google Docs or something similar to collaborate on the same document.

1. Each student in the group will estimate how many kWh of energy their actual home (or apartment or condo) uses in a typical summer month. This can be found using your home's HydroQuebec invoices, or if you live in an apartment, by asking the landlord for an estimate. The purpose of this is just to give you an idea of your home's usage, but is not required for the next parts of this project. If neither of these are possible, use a friend or family member's home as an estimate. Add this to a table (see example below) and also calculate the typical monthly cost, basing yourself on HydroQuebec's rates:

- 5.68¢/kWh for the first 30 kWh/day
- 8.60¢/kWh for the remaining energy consumption

	Home's kWh/month	**Home's cost/month**
Student 1 name		
Student 2 name		

Student 3 name		
Student 4 name*		
Student 5 name*		

**Only required for groups of 4 and 5*

2. As a team, you will make one "sample" home. Each student chooses one room from the table below and then estimates it's monthly kWh and cost.

To do this, each student will:

- Choose the room you will "create" (see table below).
- Choose a typical device for the room.
- Use the SMART amp home circuit we built to find the approximate power used by that device.
- Estimate how long the device is used for per month (show your reasoning).
- Use these to calculate the total kWh/month for that device. Enter all of these calculations in the table.
- Repeat for three other typical devices in the room.
- Add up all the devices to find the room's kWh/month. Enter it in the table.
- Calculate the total cost/month for the room using the same HydroQuebec rates.

	Specific room	**Device #1's kWh/month**	**Device #2's kWh/month**	**Device #3's kWh/month**	**Device #4's kWh/month**	**Room's total kWh/month**	**Room's total cost/month**
Student 1 name	Bedroom	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*
Student 2 name	Bathroom	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*
Student 3 name	Kitchen	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*
Student 4 name*	Living room*	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*	*calculations and answer shown here*
		calculations	*calculations*	*calculations*	*calculations*	*calculations*	*calculations*

Student 5 name*	Bedroom 2*	*and answer shown here*	*and answer shown here*	*and answer shown here*	*and answer shown here*	*and answer shown here*	*and answer shown here*

**Only required for groups of 4 and 5*

3. Add up all the rooms to get the total kWh/month and total cost/month for your team's new "sample" home:

- **Sample home's total kWh/month = _____**
- **Sample home's total cost/month = _____**

Section 2: Make your sample home an off-grid (≈1.5-2 pages single-spaced)

I recently saw Life of Grid, a Canadian about people who create their own electricity using alternative sources like solar and wind. Their homes are called "off grid" because they aren't connected to the main power grid of HydroQuebec (or the equivalent local energy provider). Some are also using their own systems for water and sewage, but we will ignore that aspect (we will just focus on being off the *electrical* grid).

Your group will provide a report on how you could make the sample home described in the previous section an entirely off-grid home using solar energy **or** wind energy. Your report will need to include:

1. Research into the amount of sunlight (or wind) the home would receive. You can assume it is on the island of Montreal with no tress or other obstructions.
2. Research into the types of solar panels (or wind turbines) that could be used to generate enough energy.
3. Research into the the types of batteries that would be required in order to make the system work. Batteries are needed to store the energy generated by the solar panels (or wind turbines) because these are unstable sources of energy which need to be stored and used as-needed (it would be hard to turn on your lights at night if they required sunlight!)
4. Cost analysis of the proposed solution. Clearly identify the solar panels (or wind turbine) components and their costs, as well as any other costs, to arrive at a final cost for implementing this off-grid solution.
5. Calculation of how many years it would take for this to be worth it. (You no longer have to pay HydroQuebec, so just figure out how many months/years of HydroQuebec savings it would take to match the initial cost of the off-grid solution).
6. *Only for groups of 4 or 5:* Research into what you could do with excess power. If you find that you are regularly producing more power than you need, what could be done with that energy? Provide a brief recap of the options HydroQuebec offers by reading this page.

Discussion	Started by	Replies	Last post
Living Room-Nintendo DSi xl charger	Chrystal McTurk	4	Nathan Violonchi Wed, 16 Mar 2016, 11:41 PM
Living Room - Electric Fireplace	Laura D'Amour	4	Nathan Violonchi Wed, 16 Mar 2016, 11:40 PM
Living Room-Iron	Emmanuelle Beaulieu	4	Nathan Violonchi Wed, 16 Mar 2016, 11:39 PM
TV Room - Play Station 3	VictorManuel GuerraLopez	4	Nathan Violonchi Wed, 16 Mar 2016, 11:37 PM
Bedroom - Speaker	Shah Zaib	5	Shah Zaib Wed, 16 Mar 2016, 3:38 PM
Office - Oil-Filled Heater	Daniel Moses	3	Nicolas Guillot Wed, 16 Mar 2016, 11:47 AM
Bedroom - Excercise bike	Andrew Mackay	3	Nicolas Guillot Wed, 16 Mar 2016, 11:45 AM
Gym Room - Treadmill	Adam Leclerc	3	Nicolas Guillot Wed, 16 Mar 2016, 11:41 AM
Bedroom - Electric Pencil Sharpener	Jonathan ChungTzeCheong	3	Tashii White Wed, 16 Mar 2016, 11:14 AM
Bathroom - Night Light	Emilie Wong	4	Richard Barina Wed, 16 Mar 2016, 10:49 AM
Bedroom - Wireless Router	Charles-Antoine Vezina	5	Richard Barina Wed, 16 Mar 2016, 10:42 AM
Bathroom - Curling Iron	Zoe Flautre	4	Joseph Palumbo Wed, 16 Mar 2016, 10:41 AM
Bathroom-Shaver Kevork Atamian	Kevork Atamian	6	Joseph Palumbo Wed, 16 Mar 2016, 10:38 AM
Bathroom-Hair straightener	Joseph Palumbo	4	Kevork Atamian Wed, 16 Mar 2016, 10:37 AM
Bedroom - Computer monitor	Tashii White	3	Tashii White Wed, 16 Mar 2016, 10:32 AM
Lava Lamp - Bedroom	Sarah Stopnicki	3	Richard Barina Wed, 16 Mar 2016, 10:29 AM
Bathroom-Hair Dryer	Rechie Wong	3	Kevork Atamian Wed, 16 Mar 2016, 10:14 AM

Bathroom - Electric razor	Vincent Lefebvre	6	Kevork Atamian Wed, 16 Mar 2016, 10:12 AM	•
Microwave- Kitchen	Sharan Basit	3	Myriam Cloutier Wed, 16 Mar 2016, 10:05 AM	•
Basement - Rice Cooker	Ramiya Edward	4	Myriam Cloutier Wed, 16 Mar 2016, 10:04 AM	•
Kitchen-Panini grill	Brigitte Laberge-Brooks	3	Myriam Cloutier Wed, 16 Mar 2016, 10:03 AM	•
Bedroom-Desk lamp	Alexia Gladysz	4	Mazin Ageeb Wed, 16 Mar 2016, 9:59 AM	•
Bedroom - TV	Elissa Colella	6	Mazin Ageeb Wed, 16 Mar 2016, 9:57 AM	•
Bedroom 1 - Alarm Clock Radio	Kira-Marie Lazda	4	Mazin Ageeb Wed, 16 Mar 2016, 9:54 AM	•
Bedroom- IPhone Charge	Katherine Scott	4	Brandan Ranaldi Wed, 16 Mar 2016, 9:28 AM	•
Bedroom 1- Alarm Clock	Caylie Kambranis	3	Brandan Ranaldi Wed, 16 Mar 2016, 9:26 AM	•
Basement(Bedroom)-Miscellaneous Batterie charger	Alexandre Parent	4	Brandan Ranaldi Wed, 16 Mar 2016, 9:24 AM	•
Counter Plug (Kitchen) - Kettle	Bailey Roy	3	AlanAlberto RamirezGuevara Wed, 16 Mar 2016, 9:06 AM	•
Kitchen - Blender	Nathalie Faragalla	3	AlanAlberto RamirezGuevara Wed, 16 Mar 2016, 9:04 AM	•
Kitchen-Blender	Julie Dodds	5	AlanAlberto RamirezGuevara Wed, 16 Mar 2016, 9:02 AM	•
Kitchen-Slow cooker	Emily Delisle	5	AlanAlberto RamirezGuevara Wed, 16 Mar 2016, 8:59 AM	•
Kitchen- Water Fountain	Samantha Boivin	5	AlanAlberto RamirezGuevara Wed, 16 Mar 2016, 8:56 AM	•
Kitchen- Popcorn maker	Alex Anderson	5	AlanAlberto RamirezGuevara Wed, 16 Mar 2016, 8:53 AM	•
Kitchen-Magic Bullet	AfifahNaila Bestari	5	AlanAlberto RamirezGuevara	•

Kitchen Magic Bullet				
				Wed, 16 Mar 2016, 8:51 AM
Kitchen-Rice cooker	Vanessa Ollado	3	AlanAlberto RamirezGuevara	Wed, 16 Mar 2016, 8:48 AM
Kitchen - Kitchen-Aid Mixer	Nikki vanNoord	2	Dilaxsana Senthoorkumaran	Wed, 16 Mar 2016, 8:41 AM
Kitchen - Handheld Mixer	David Ste-Marie	2	Dilaxsana Senthoorkumaran	Wed, 16 Mar 2016, 8:40 AM
kitchen, water machine	Mohamed Sahno	3	Dilaxsana Senthoorkumaran	Wed, 16 Mar 2016, 8:38 AM
Bedroom - Desktop Monitor	Mazin Ageeb	4	Elissa Colella	Wed, 16 Mar 2016, 1:25 AM
Southwest Bedroom - Christmas lights	Katharine Mallett	1	Muhamad Sarris	Wed, 16 Mar 2016, 12:27 AM
garage - air tank	Matthias Ho	2	Muhamad Sarris	Wed, 16 Mar 2016, 12:24 AM
Garage, garage opener	Muhamad Sarris	3	Muhamad Sarris	Wed, 16 Mar 2016, 12:21 AM
Project- pool room/ message chair	Katheryne Dubreuil	1	Jonathan ChungTzeCheong	Wed, 16 Mar 2016, 12:21 AM
Gym - Elliptical	William Chevrier	2	Jonathan ChungTzeCheong	Wed, 16 Mar 2016, 12:20 AM
Garage - Circular Saw	Nicolas Guillot	3	Andrew Mackay	Tue, 15 Mar 2016, 11:52 PM
Kitchen - Food Chopper	Ryan Richard	2	Marie-Eve Newberry	Tue, 15 Mar 2016, 11:38 PM
Kitchen - Waffle Maker	Gillian Nyberg	4	Marie-Eve Newberry	Tue, 15 Mar 2016, 11:36 PM
Kitchen-5in1 Griller	Berfu Nalcakar	3	Marie-Eve Newberry	Tue, 15 Mar 2016, 11:33 PM
Bedroom-CDPlayer	Hassan Charafeddine	2	Katheryne Dubreuil	Tue, 15 Mar 2016, 11:26 PM
Basement - Printer	Markorios Mikhail	4	Katherine Tracy	Tue, 15 Mar 2016, 11:26 PM

Kitchen - Roomba Robot Vacuum	Timothy Bajohr	1	Paul Attara Tue, 15 Mar 2016, 11:24 PM
Basement - Powered Speaker Amplifier	David Castonguay	4	Katherine Tracy Tue, 15 Mar 2016, 11:24 PM
Basement - DRYER	Keshita Ramchurreetoo	3	Katherine Tracy Tue, 15 Mar 2016, 11:19 PM
Basement - Wii Console	Jamie Halperin	5	Louis-Philippe Amyot Tue, 15 Mar 2016, 11:16 PM
Basement-Printer	Manar AlchiraziAlsabbagh	4	Louis-Philippe Amyot Tue, 15 Mar 2016, 11:15 PM
Basement-Guitar Amplifier	Henri Rofiq	4	Louis-Philippe Amyot Tue, 15 Mar 2016, 11:14 PM
Basement - Xbox One	Spencer Handfield	4	Louis-Philippe Amyot Tue, 15 Mar 2016, 11:12 PM
Basement - Electric Drum Set	Raphael Geoffrion	3	Katherine Tracy Tue, 15 Mar 2016, 11:10 PM
Kitchen - Raclette	Marie-Eve Newberry	2	Ryan Richard Tue, 15 Mar 2016, 10:40 PM
Basement - Hot Water Tank	Katherine Tracy	3	Markorios Mikhail Tue, 15 Mar 2016, 10:04 PM
Television-Living Room	Shahzeb Malik	4	Gabriella Volpato Tue, 15 Mar 2016, 9:53 PM
Family Room - Vacuum Cleaner (Good Post)	Michael DeMeo	3	Gabriella Volpato Tue, 15 Mar 2016, 9:51 PM
Living Room - Electric Keyboard	Kirstin Buenviaje	4	Gabriella Volpato Tue, 15 Mar 2016, 9:49 PM
Kitchen - Blender	Paul Attara	1	Timothy Bajohr Tue, 15 Mar 2016, 9:28 PM
Bedroom - Clothes Iron	Harjeet Sandhu	2	Kayla Preszow Tue, 15 Mar 2016, 9:14 PM
Bedroom - Desktop Computer	Richard Barina	3	Sarah Stopnicki Tue, 15 Mar 2016, 9:12 PM

Bedroom- Aquarium heater	Elizabeth Sinodinos	2	Kayla Preszow Tue, 15 Mar 2016, 9:10 PM
Living Room - Home Audio System	Shianne Weir-Francis	2	Kate Ward Tue, 15 Mar 2016, 8:57 PM
Dining Room - Speaker System	Maryssa Bizier-Stern	3	Kate Ward Tue, 15 Mar 2016, 8:56 PM
Living Room - Digital Picture Frame	Kate Ward	2	Shianne Weir-Francis Tue, 15 Mar 2016, 8:52 PM
Basement - VCR	Nathan Violonchi	4	VictorManuel GuerraLopez Tue, 15 Mar 2016, 8:48 PM
Dining Room - Fan	Miraaj Ahmed	2	Shianne Weir-Francis Tue, 15 Mar 2016, 8:45 PM
Kitchen-phone base	Gabriella Volpato	3	Shahzeb Malik Tue, 15 Mar 2016, 8:30 PM
basement-computer	Louis-Philippe Amyot	5	Spencer Handfield Tue, 15 Mar 2016, 7:10 PM
Kitchen-electric can opener	AlanAlberto RamirezGuevara	3	Vanessa Ollado Tue, 15 Mar 2016, 6:59 PM
Bathroom - Electric toothbrush	Sabrina ChanChunKong	3	Kathleen Kowalchuk Tue, 15 Mar 2016, 6:54 PM
Bedroom - Electric Heater	MarkVincent Avena	3	Kathleen Kowalchuk Tue, 15 Mar 2016, 6:52 PM
Bedroom-Floor Lamp	Nithya Chari	4	Kathleen Kowalchuk Tue, 15 Mar 2016, 6:50 PM
Bedroom- Speaker	Brandan Ranaldi	3	Alexandre Parent Tue, 15 Mar 2016, 6:15 PM
Kitchen - Bread Maker	Myriam Cloutier	3	Ramiya Edward Tue, 15 Mar 2016, 5:24 PM
Kitchen-Toaster Oven	Diana Mitroi Banu	2	Shania Moniriaval Tue, 15 Mar 2016, 1:13 PM
Kitchen - Cuisinart Fondue Pot	Melissa McCue	3	Shania Moniriaval Tue, 15 Mar 2016, 1:12 PM
Kitchen - Coffee Machine	Julia Macintosh	2	Shania Moniriaval Tue, 15 Mar 2016, 1:08 PM

Kitchen- Microwave	Dilaxsana Senthoorkumaran	2	David Ste-Marie Tue, 15 Mar 2016, 12:55 PM	•
Kitchen-Smoothie Blender	Shania Moniriaval	2	Diana Mitroi Banu Mon, 14 Mar 2016, 10:54 PM	•
Kayla's Bedroom - Dell Laptop Charger	Kayla Preszow	2	Elizabeth Sinodinos Mon, 14 Mar 2016, 10:00 PM	•
Back Bedroom - Portable Radio	Kathleen Kowalchuk	3	MarkVincent Avena Mon, 14 Mar 2016, 7:52 PM	•
kitchen, water machine	Mohamed Sahno	0	Mohamed Sahno Sun, 13 Mar 2016, 8:54 PM	•
Family Room - Vacuum cleaner	Michael DeMeo	0	Michael DeMeo Sun, 13 Mar 2016, 3:44 PM	•

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