E.1.

# Appendix E.1. Classroom Assignments at George School

Here are the classroom assignments that are given to each of the *Computer Programming & Robotics* classes at George School. Most of assignments involve reading some portion of a chapter in this textbook and solving some of the **Challenge Problems**, which are found at the end of each chapter. Somewhat flexible timelines are given for the assignments because ours is a student-driven course, allowing students to follow a pace that suits their needs and interests. While there is no maximum speed with which you can cover the material, there is a minimum speed that must be adhered to. Students having difficulty keeping the minimum pace must come to Consultations, the Friday Supplemental Lecture, or complete their classwork for homework.

Generally speaking, students should complete *Volume One* of the text during **Term 1** and *Volume Two* during **Term 2**. (See *Appendix E Section 2* for details about the timeline for our projects.) Adhering to this timeline will permit you to spend the entirety of **Term 3** on your independent final project!

## E.1.1. First Monday Introductions

* Welcome and introductions
* Assign computers, robots, and toolboxes to each student.
  + Record the device numbers for each student
  + Which students will bring their own computer, and which will use a school machine?
* Log into computers. This may take a while. Remember your laptop number!
* Create e-mail distribution list
* Have students think about what kind of textbook they want. Here are the hard-copy options:
  + Black & White, spiral bound: $22.56
  + Color, perfect bound: $32.39
  + If you are unable to afford the book or if you must have an e-copy of the text, talk to Chris.
* Otherwise, there is nothing else they need to purchase for the class. (Some supplies will be given to you tomorrow, and will be charged to your account.)
  + Students may wish to buy a small notebook that can be stored in the bottom of the toolbox. (Have an example on hand to display.) Notebooks are often used by programmers to work out their algorithms on paper before coding them into the computer!
* Point out location of syllabus on Canvas.
  + Discuss syllabus and safety concerns.
* Have fun with some Robot Demos, such as:
  + YouTube playlist from last year’s Open House (see Pages on Canvas)
  + LCD output
  + Student-made LED screen (thanks, Ellie Clermont!)
  + Line Following 3D-Printed Robot
  + Robosapien
  + IR Card Swipe
  + Fingerprint Reader
  + RGB LEDs with Bluetooth activation
  + MP3 Player
  + Kynex robot
  + ESRA
  + Tank
  + 3D Printer
  + etc
* **Homework:**
* **Read the course syllabus on Canvas >> Files >> Syllabus & Course Info**
* **If you plan to use your own computer, download and install the following before October:**
  + - **SketchUp Software**
      * Download SketchUp (<http://www.sketchup.com/download>). Select “Educational Use”.
      * SketchUp Make is free
      * Download and install the SketchUp STL plugin. (ITS may not yet have installed this on all machines.) You can get this in the Files section on Canvas:
    - **Repetier 3D Printer Software**
      * Download and install the Repetier-Host from <https://www.repetier.com/>.
      * This is a free download, but I recommend supporting this excellent piece of software with a small donation. It is worth it!
    - **MakerBot 3D Printer Software**
      * Download and install the MakerBot Makerware from <http://www.makerbot.com/desktop>.
      * Select MakerBot Replicator 2 (not 2X)
    - **Express PCB (printed circuit board) CAD Software**
      * Download and install ExpressPCB from <https://www.expresspcb.com/free-cad-software/>.
      * It is a free download
      * You do **not** need to install ExpressSCH
* **(*Optional*) For those interested in building a resume, you may want to create your own “academic/professional” YouTube or other video-posting channel. You can post videos of your robotic projects here, so parents, friends, college admission people, and future employers may hit on this page.**
* **(*Optional*) Create a Twitter account and follow GSRobotics**

## E.1.2. Day 2 Beginnings

* Any questions about the syllabus?
* Log into computers. This may take a while. Remember your laptop number!
* Create folders for the following projects:
  + Arduino or Teensy sketches (robot apps)
  + SketchUp designs for 3D printing
  + ExpressPCB circuit board designs
* ~~Distribute and verify last year’s out “Robot distribution (Last day of school).docx” document.~~
* Pass out toolboxes, which belong to George School. They should contain:
  + Robot parts including chassis, motors, wheels, standoffs, spacers, hardware, and Velcro strip
  + Large and small hex wrenches
  + Screwdriver multi-tool
  + Sensors and Passives including Sharp IR, Sonic (3), LED circuits (2)
  + Etc.
* Pass out the following, which have been purchased by students:
  + Teensy 3.2 microcontroller
  + Teensy 3.2 Pinout Card
  + Programming cable
* In a couple of weeks, pass out the rest of the equipment purchased by the students:
  + PRT3 Motherboard kit
  + Batteries and battery pack
  + Electronics kit from Jameco
  + Connecting wires (male-male, female-female, and male-female)
* Download and install the SketchUp STL plugin. (ITS may not yet have installed this on the school machines.) You can get this either in the bookmark or handout sections on the LMS. (Go to our class page and click on “3D Printing”.)

## E.1.3. Chapter 1 – Introduction to Physical Computing

1. **Together as a class:**
   1. Open this document from **Canvas >> Files >> Syllabus & Course Info**
   2. If you have not yet done so, create folders for the following projects:
      * Arduino or Teensy sketches (robot apps)
      * SketchUp (3D printing)
   3. Follow along in *Chapter 1: Introduction to Physical Computing* and perform all the steps with your own microcontroller. It is fine to skip Section 7 (Details about Microcontrollers for *Serious* Programmers). Along the way, you will need to do the following:
      * Install the Arduino IDE @ <https://www.arduino.cc/en/Main/Software>
      * Install the Teensyduino @ <https://www.pjrc.com/teensy/td_download.html>
      * Allow the computer time to recognize the new Teensy hardware
      * Play with the Blink sketch
      * Answer the following Challenge Problems together as a class:
        + 1, 2, 4, 8, 9, 13
      * Answer the following Challenge Problems with individual effort:
        + 10, 11
        + Have the instructor *visually check* your solution code before proceeding.
      * **Intensive students** answer the following Challenge Problems:
        + 12
        + Have the instructor *visually check* your solution code before proceeding.

## E.1.4. 3D Printing – An Introduction and the First Print

1. Open the document, **“How to 3D Print at George School”**, which can be found on **Canvas >> Files >> 3D Printing & CAD Files**.
2. **Together as a class:**
   1. Go over the **SketchUp Setup** section of the document.
   2. Follow the steps in the **Playing Around with SketchUp Tools** section of the document.
3. **Create a nameplate for your toolbox shelf**
   1. Follow the steps in the **Your First REAL SketchUp Design** section of the document.
      * Design a nameplate using SketchUp
      * Export the file as an STL File
4. **Turn the nameplate** **STL file into G-Code using Repetier** 
   1. Follow the steps in the **Repetier Host Software Instructions** section of the document.
5. **Print your nameplate**
   1. Follow the steps in the **Prusa i3 Printer Instructions** section of the document.
      * Load the file(s) on an SD card and print it using the 3D printers

## E.1.5. Chapter 2 – Serial Output and Intro to Functions

1. **All students:** 
   * According to your own needs and learning styles, read/skim/peruse/digest *Chapter 2: Serial Output and Introduction to Functions* so that you are able to successfully answer the following Challenge Problems.
     + Pay special attention to *Section 2.3* on the use of comments. Even though our code will work just fine without them, comments are an important component of this course and your grade.
2. Carefully read how to set up your Challenge Problem coded sketch, which is found on the first page of the Challenge Problems section at the end of *Chapter 2*. You should follow this template example for each of your Challenge Problem sets.
3. **Intermediate students:** 
   * **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
     + **All: 5, 7, 8, 12**
     + ~~1, 7, 9, 10, 11, 12~~
     + *Optional Graded Bonus*: 5
     + For Problems 1 and 7, enter your answer within a multi-line comment block.
     + *For any questions that did not require a solution to be turned in, you may ask your instructor to check your solution code and output.*
     + Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
4. **Intensive students:**
   * **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
     + ~~1, 4, 7, 9, 10, 11, 12~~
     + *Optional Graded Bonus*: 5
     + For Problems 1 and 7, enter your answer within a multi-line comment block.
     + *For any questions that did not require a solution to be turned in, you may ask your instructor to check your solution code and output.*
     + Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.6. Chapter 3 – Data Types, Variables, and Constants

1. **All students:** 
   1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 3: Data Types, Variables, and Constants* so that you are able to successfully answer the following Challenge Problems.
2. **Intermediate students:** 
   1. **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
      * 3, 5, 7, 8, 9, 10, 11, 12, 14, 16, 17, 21 , 24, 30
      * ~~3, 5, 7, 8, 9, 10, 11, 12, 17, 20, 21, 22, 23, (24 or 25)~~
      * For any problems that ask for a *predicted* outcome (Problems 6-25), record your predicted output on the Predictive Worksheet or on paper or as a comment in the Arduino IDE. Do **not**, however, enter the code into the IDE and compile it. I want to see if you can *deduce* what the outcome will be, not *read* what the outcome is!
      * *For any questions that did not require a solution to be turned in, you may ask your instructor to check your solution code and output.*
3. **Intensive students:**
   1. **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
      * 1, 2, 3, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16 – 19, 21, 22, 24, 31 , 32 (a or b; The MJ2() function)
      * ~~1, 2, 3, 5, 7, 8, 9, 10, 11, 12, 17, 20, 21, 22, 23, 25, 26.b (The MJ2() function)~~
      * For any problems that ask for a *predicted* outcome (Problems 6-25), record your predicted output on the Predictive Worksheet or on paper or as a comment in the Arduino IDE. Do **not**, however, enter the code into the IDE and compile it. I want to see if you can *deduce* what the outcome will be, not *read* what the outcome is!
      * *For any questions that did not require a solution to be turned in, you may ask your instructor to check your solution code and output.*
      * Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.7 Chapter 4 – Arithmetic and Rounding

1. **All students:** 
   1. Read *Appendix A: Helpful Programming Hints* and follow these guidelines when writing solutions to the Challenge Problems at the end of each chapter.
2. **Intermediate students:** 
   1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 4: Computer Arithmetic and Rounding* so that you are able to successfully answer the following Challenge Problems. You may skip *Section 3: Modulo and Integer Division*.
   2. **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
      * 2a-d (have teacher grade it now), 5, 13, 16 (you must confirm your answers are correct with Google or another online converter) , 21, 31,
      * Finance: 40 & 41
      * ~~2a-d, 3, 5, 13, 16, 31, 41.b~~
      * *For any questions that did not require a solution to be turned in, you may ask your instructor to check your solution code and output.*
      * Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
3. **Intensive students:**
   1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 4: Computer Arithmetic and Rounding* so that you are able to successfully answer the following Challenge Problems.
   2. **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
      * 2a-g (have teacher grade it now), 3-4 (see teachers for answers), 6, 14, 16 (you must confirm your answers are correct with Google or another online converter), 21, 31, 43
      * Finance: 40 & 41
      * ~~2a-g, 3, 4, 5, 7, 14, 17, 31, 41.b, 43~~
      * *~~Optional Bonus~~*~~: 8~~
      * *For any questions that did not require a solution to be turned in, you may ask your instructor to check your solution code and output.*
      * Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.8. Progress Quiz #1: Chapters 1-4

1. **All Students:** Take the **Chapters 1-4 Progress Quiz**. Ask your teacher for the quiz materials.

## E.1.9. Chapter 5 – Functions and Arguments

1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 5: Functions with Arguments* so that you are able to successfully answer the following Challenge Problems. Carefully read and perform all the steps with your own microcontroller.
2. **Intermediate Students:**
   1. **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
      * 1, 2, 4, 5,
      * ~~1, 2, 4, 5, 11, 16~~
      * *For any questions that did not require a solution to be turned in, you may ask your instructor to check your solution code and output.*
      * Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
3. **Intensive Students:**
   1. **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
      * 1, 2, 4, 14, 16, 22, 34
      * ~~1, 2, 4, 14, 16, 22, 34~~
      * *Optional Bonus*: 8 (This is a difficult problem, with many possible solutions.)
      * *For any questions that did not require a solution to be turned in, you may ask your instructor to check your solution code and output.*
      * Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.10. Chapter 6 – Serial Keyboard Input and Modular Programming

1. **ALL Students:**
   1. If you haven’t already, create a folder named “**modules**” where you normally store your program files. Next, navigate your browser to **Canvas >> Files >> Modules for GS Students**, and copy the “SKIF.ino” file into the **modules** folder you just created. Having this module will save you from having to enter all the SKIF commands by hand!
   2. Quickly **skim** *Chapter 6: Serial Keyboard Input and Modular Programs* and learn how to ***use* the SKIF commands** that are discussed in the chapter. The SKIF commands that are discussed within the chapter are given to you in the SKIF.ino module, as explained in the above step. When the book asks you to build the SKIF module, I recommend that you simply use the provided module that you downloaded, rather than typing in the code by hand.
   3. **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
      * 1, 4
      * *Optional Bonus*: #43 (For this problem, the current SKIF functions are unable to read scientific notation. Therefore, you will either need to ask the user to first enter the mantissa and then the exponent, or your will need to create your own **readScientificNotation()** function to solve this problem.)
      * *Have your instructor examine and grade your solution code before proceeding*.

## E.1.11. Progress Quiz #2: Chapters 5-6

1. **All Students:** Take the **Chapters 5 & 6 Progress Quiz**. Ask your teacher for the quiz materials.

## E.1.10. Chapter 7 – Advanced Mathematics

1. **ALL students** can skip this chapter.
2. **~~Intensive students should:~~**
   1. ~~Carefully~~ **~~read~~***~~Chapter 7: Advanced Mathematics~~* ~~and~~ **~~perform~~** ~~all the steps with your own microcontroller.~~
   2. **~~Solve the following Challenge Problems.~~** 
      * + ~~8, 31~~
        + ~~Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.~~

## E.1.12. Chapter 8 – Random Numbers

1. **ALL Students:**
   1. If you haven’t already, create a folder named “**modules**” where you normally store your program files. Next, navigate your browser to **Canvas >> Files >> Modules for GS Students**, and copy the “randomModule.ino” file into the **modules** folder you just created. Having this module will save you from having to enter all the random number generator commands by hand!
   2. Quickly **skim** *Chapter 8: The Random Number Generator* and **learn** how to make use of the random number generator commands that are discussed in the chapter. The random number commands that are discussed within the chapter are given to you in the randomModule.ino module, as explained above. When the book asks you to build the random number module, I recommend that you simply use the provided module that you downloaded, rather than typing in the code by hand.
   3. **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
      * 6, 8
      * *Optional Bonus:* 12 (Redo #31 in Chapter 4)
      * *Have your instructor examine and grade your solution code before proceeding*.

## E.1.13. Chapter 9 – If-Then Logic Statements

1. **~~Together as a class:~~**
2. ~~Watch the “Sorcerer’s Apprentice” portion of the Disney animated musical,~~ *~~Fantasia~~*~~, which occurs 28 minutes, 48 seconds after the start of the film. (The clip runs for about ten minutes.) Watch it with an eye of a computer programmer. Specifically think about Mickey Mouse’s actions as a computer program with instructions were too open-ended. What restrictions should he have imposed on the brooms with logic statements?~~
3. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 5: Functions with Arguments* so that you are able to successfully answer the following Challenge Problems. Carefully read and perform all the steps with your own microcontroller.
   1. **Intermediate students:**
      * You may skip Example 7d, Demonstration 4, and the sections in the chapter that cover truth tables.
      * **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
        + 1, 2, 3, 4, 5, 6, 7, 8, 14, 15. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
        + 19 (use an **if-else** block), 19 (use a **switch-case** block), 29
        + Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
   2. **Intensive students:**
      * **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
        + 1 – 15. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
        + 19 (use an **if-else** block), 19 (use a **switch-case** block), 22, 29
        + Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.14. Progress Quiz #3: Chapters 7-9

* **All Students:** Take the **Chapters 8 & 9 Progress Quiz**. Ask your teacher for the quiz materials.

## E.1.15. Chapter 10 – While- and Do-While Loops

1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 10: While and Do-While Loops* so that you are able to successfully answer the following Challenge Problems. Carefully read and perform all the steps with your own microcontroller.
   1. **Intermediate students:**
      * You may skip the last two sections (Sections 5 and 6) on the formal treatment of series and sequences and using real time clocks.
      * **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
        + 1 – 16. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
        + 21, 28, 29 (turn in your spreadsheet along with your code on the LMS), 36, 42, 47
        + Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
   2. **Intensive students:**
      * You may skip Section 5 on the formal treatment of series and sequences.
      * You **should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
        + 1 – 16. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
        + 21, 23, 25, 28, 29 (turn in your spreadsheet along with your code on the LMS), 36, 40, 43, 47, 50, 62
        + Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.16. Chapter 11 – For-Loops

1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 11: For Loops* so that you are able to successfully answer the following Challenge Problems. Carefully read and perform all the steps with your own microcontroller.
   1. **Intermediate students:**
      * **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
        + 1 – 16. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
        + 25, 27, 40, 43, 52, 53
        + Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
   2. **Intensive students:**
      * **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
        + 1 – 16. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
        + 25, 27, 40, 43, 45, 52, 53, 56
        + Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.17. Progress Quiz #3: Chapters 7-9

1. **All Students:** Take the **Chapters 10 & 11 Progress Quiz**. Ask your teacher for the quiz materials.

## ~~E.1.18. Chapter 12 - Going Forward with Physical Computing~~

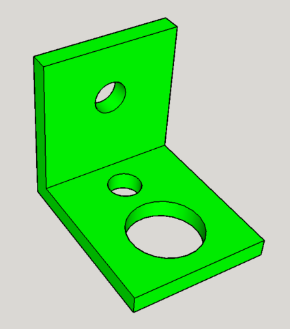
1. **~~All students:~~**
   1. ~~Carefully read Chapter 12, Section 2, and perform all the steps with your own microcontroller. Specifically, read the following sub-sections:~~
      * + ~~The Patton Robotics PRT3 Motherboard~~
        + ~~How to Build and Solder the PRT3 Motherboard~~
        + ~~The Patton Robotics OneBot Mobile Robot~~
   2. **~~Solve the following Challenge Problems.~~** 
      * + ~~14, 15, 16, 17~~

## E.1.19. Chapter 13 – Vol 2 Chapter 13 - An Intro to Electronics and Getting to Know the PRT3 Motherboard

1. Together as a class, we will go over the important points of *Chapter 13 - An Intro to Electronics and Getting to Know the PRT3 Motherboard*. If others are still working on material from Volume One, you may proceed directly to the steps below and wait for your classmates to catch up with you.
2. Do the following problems together as a class:
   * + 5, 6, 8, 9, 11, 14-19, 20 (a, e, i), 21-22, 23-24 (refer to image on page 540), 25, 28 (left side only), 30 (refer to image on page 540)
3. **All Students:** Take the **Chapter 13 Progress Quiz**. Ask your teacher for the quiz materials.
   * + 27, 28 (both sides), 29 (both sides), 31
4. ~~Post Quiz Activity:~~
   * + ~~Load “Blink.ino” into your Teensy that is inserted into a PRT3 Motherboard.~~
     + ~~Connect a piezo buzzer between~~ **~~signal pin #13~~** ~~and ground.~~
     + ~~You will know that it is connected correctly if the buzzer beeps in time with the LED. (Unplug the buzzer to avoid headaches!)~~
     + ~~Alter the frequency in code.~~
5. Before you can solder, do this **AT HOME**: read the “How to Solder by SparkFun” and “How to Solder by Instructibles” and watch the SparkFun YouTube video, all of which can be found on **Canvas >> Pages >> Soldering Tips**.
6. **ALL students:**
   * + **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
       - * 1, 2, 3. Your teacher must check your **solder work** after each problem before you can proceed!

## E.1.20. Independent Non-Chapter Work

1. **You are required to do the following at some point early this term:**
   * + **Label** your Teensy microcontroller. Your teacher will give you stick-on labels for this.
     + **Label** your PRT3 Motherboard. Your teacher will give you stick-on labels for this.
     + **Label** your six NiMH batteries. Your teacher will give you stick-on labels for this.
     + **Charge** your battery pack. Your teacher will show you how.
     + **Build** your **OneBot Robot**
       - Read how to build the robot here: <http://pattonrobotics.com/products/onebot-basic-complete>
2. **Together as a class:**
   * + **Design and build a license plate** for your OneBot, which will be fabricated on the **100-watt Boss Laser Cutter** in the lab.
       - We will do this together as a class using the RDWorks software.  The software is free, but only works on a PC machine.  You can download it here: <https://www.bosslaser.com/laser-software/>, or you may use a school computer for the design work.
       - The recommended dimensions are 60mm x 30mm (L x W)
       - You will need at least one hole to be tapped for a 4-40 screw.  The **diameter** of this hole should be 2.261mm.  This hole will mate to the 3D-printed license plate mount, which you will make in another assignment.
       - The "license plate" can be a vanity plate, nametag, or other fun and artistic identifier.
       - Cut the plate out of wood.
       - Use the speed and power settings that are appropriate for the type of wood you are using.

1. **Design and 3D-print a mount** for your license plate.
   * + Review how to 3D print with the document, “How to 3D Print at George School.pdf”, which is on **Canvas >> Files >> 3D Printing & CAD Files**
     + Make a simple L-bracket mount that will allow you to attach your laser-cut license plate to your OneBot. Pictured to the right is one suggestion.
     + The dimensions of the L-bracket are up to you. Sketch your design on paper, and use a vernier caliper to make any necessary measurements before you begin your design work.
     + How the license plate mounts to the L-bracket is up to you, but recall that the license plate has at least one 4-40 tapped mounting hole for this purpose.
     + The L-bracket can be secured to the OneBot in a number of ways. For example, the OneBot has a number of 4-40 tapped holes, 4-40 through holes, and a ¼” threaded rod for the tail wheel.
     + **You can spend only one class period on this assignment.** If you need more time for this, you must do it outside of class.
2. **(Optional) ExpressPCB project:**
   * + Design a printed circuit board

## E.1.21. Chapter 14 – Getting Started with Circuits

1. Together as a class, we will go over the important points of *Chapter 14 - Getting Started with Circuits*:
   * + A **quick** tour through resistors, capacitors, diodes, LEDs, buzzers, audio transducers, transistors.
     + Examine Table 14.1
     + Breadboard “theory” and a friendly “quiz”: Figures 14.21, 14.22, 14.23.
     + Quickly discuss **resistors in series (pages 566-567)**:
       - Grab three resistors from your box and measure them with a DMM.
       - Looking only at Figure 14.34, build the circuit on your breadboard.
       - Measure the equivalent resistance, , with your DMM.
       - Predict the equation for and compare it to Equation 14.1.
     + Quickly discuss **resistors in parallel (pages 567-568)**:
     + Grab three resistors from your box and measure them with a DMM.
     + Looking only at Figure 14.38, build the circuit on your breadboard.
     + Measure the *equivalent resistance*, , with your DMM.
     + Can you predict the equation for , which is shown with it to Equation 14.3.
     + Mention Ohm’s Law for current and past physics students, but we will not cover this material in any depth.
2. Do the following Challenge Problems together as a class:
   * + 6. (Use a breadboard and jumper wires (not alligator wires) for this problem!)
3. **All Students:** Take the **Chapter 14 Progress Quiz**. Ask your teacher for the quiz materials.

## E.1.22. Chapter 15 – Creating Sound and Light with a Breadboard and PRT3 as the Voltage Source

1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 15 - Creating Sound and Light with a Breadboard and PRT3 as the Voltage Source* so that you are able to successfully answer the following questions and Challenge Problems. Carefully read and perform all the steps with your own microcontroller.
   * + **Intermediate students:**
       - **Build the buzzer circuits shown in Figures 15.4 and 15.11.** Try to build them without looking at the photographs of the built circuits, for you will be required to build them without images on the exam! After each circuit is built, have your instructor check them!
       - **Build the LED circuit shown in Figures 15.23.** Try to build them without looking at the photographs of the built circuits, for you will be required to build them without images on the exam! After the circuit is built, have your instructor check it!
       - **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
         * 3, 4, 5, 6, 8 (see note below), 18, 20
         * Instructions for the 3D-printed LED light diffusion dome:

Read pages 590-591 for help with this.

**You can spend only one class period on this assignment.** If you need more time for this, you must do it outside of class.

* + - * Turn in your written work on paper, and show your circuits/3D prints to your instructor before proceeding to the next chapter.
    - **Intensive students:**
      * **Build the buzzer circuits shown in Figures 15.4, 15.11, and 15.13.** Try to build them without looking at the photographs of the built circuits, for you will be required to build them without images on the exam! After each circuit is built, have your instructor check them!
      * **Build the LED circuits shown in Figures 15.23 and 15.25.** Try to build them without looking at the photographs of the built circuits, for you will be required to build them without images on the exam! After the circuits are built, have your instructor check them!
      * **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
        + 3, 4, 5, 6, 8 (see note below), 18, 22
        + Instructions for the 3D-printed LED light diffusion dome:

Read pages 590-591 for help with this.

**You can spend only one class period on this assignment.** If you need more time for this, you must do it outside of class.

* + - * Turn in your written work on paper, and show your circuits/3D prints to your instructor before proceeding to the next chapter.

## E.1.23. Chapter 16 – Creating Sound & Light with digitalWrite

1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 16 - Creating Sound & Light with digitalWrite* so that you are able to successfully answer the following Challenge Problems. Carefully read and perform all the steps with your own microcontroller.

* + - **Intermediate students:**
      * **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
        + 1-4, 7, 8. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
        + 9, 15, 34 (use one tricolor RGB LED), 35, 38 (make one pattern).
    - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
    - **Intensive students:**
      * **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
        + 1-4, 7, 8. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
        + 10, 15, 28, 34 (use one tricolor RGB LED), 35, 38 (make one pattern).
      * Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.24. Chapter 17 – Creating Sound & Light with Pulse Width Modulation using analogWrite and digitalWrite

1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 17 – Creating Sound & Light with Pulse Width Modulation using analogWrite and digitalWrite* so that you are able to successfully answer the following Challenge Problems. Carefully read and perform all the steps with your own microcontroller.
   * + **Intermediate students:**
       - **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
         * 2, 4-12. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
         * 19, 23, 28.
       - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
     + **Intensive students:**
       - **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
         * 2, 4-14. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
         * 19, 20, 23, 28, 35.
       - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.25. Chapter 18 – Introduction to Servomotor Programming

1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 18 – Introduction to Servomotor Programming* so that you are able to successfully answer the following Challenge Problems. Carefully read and perform all the steps with your own microcontroller.
   * + **Intermediate students:**
       - **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
         * 1, 2, 4-19. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
         * 20, 23, 27.
       - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
     + **Intensive students:**
       - **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
         * 1-19. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
         * 20-22, 23, 24, 27.
       - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.26. Chapter 19 – Making Your Robot Move with Servomotors

1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 19 – Making Your Robot Move with Servomotors* so that you are able to successfully answer the following Challenge Problems. Carefully read and perform all the steps with your own microcontroller.
   * + **Intermediate students:**
       - You should be able to program your robot to perform Candy Challenges #1 and #2 on pages 727-728.
       - **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
         * 1-13. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
         * 21, 31, 33, 36, 41, 44
       - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
     + **Intensive students:**
       - You should be able to program your robot to perform Candy Challenges #1, #2, #3, and #4 on pages 727-728.
       - **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
         * 1-13. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
         * 21, 31, 33, 36, 41, 44
       - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.27. Chapter 20 – Infrared Range-Finding (Analog) Sensors

1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 20 – Infrared Range-Finding (Analog) Sensors* so that you are able to successfully answer the following Challenge Problems. Carefully read and perform all the steps with your own microcontroller.
   * + **Intermediate students:**
       - **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
         * 1, 3-10, and 22. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
         * 11, 13, 14, 21, 29, and 33.
       - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
     + **Intensive students:**
       - **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
         * 1-10, 20, and 22. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
         * 11, 13, 14, 15, 21, 29, 30, 32, 33.
       - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.28. Chapter 21 – Environmental Sensing with Voltage Dividers and Other Analog Sensors

1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 21 – Environmental Sensing with Voltage Dividers and Other Analog Sensors* so that you are able to successfully answer the following Challenge Problems. Carefully read and perform all the steps with your own microcontroller.
   * + **Intermediate students:**
       - **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
         * 8, 9, 12, 13, 14, 15, 21, 26. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
         * If you have not already programmed your robot to follow a line, then do Problem #1.
         * 31 (choose one output unit), 36, 42, 46, 50, 55 (do this with everyone).
       - Turn in your work to be graded by outputting your coded solution as a PDF and turn it into Canvas on the LMS. Once your work has been handed in, you may proceed to the next chapter.
     + **Intensive students:**
       - **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
         * 8, 9, 12, 13, 14, 16, 19, 21, 22, 26. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
         * If you have not already programmed a line-follower that also responds to some external stimuli, then do Problem #3.
         * 32, 36, 42, 46, 49, 50, 55 (do this with everyone), 56.
       - Turn in your work to be graded by outputting your coded solution as a PDF and turn it into Canvas on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.29. Chapter 22 – Ultrasonic Rangers, Buttons, Whiskers, and Other Digital Sensors

1. According to your own needs and learning styles, read/skim/peruse/digest *Chapter 22 – Ultrasonic Rangers, Buttons, Whiskers, and Other Digital Sensors* so that you are able to successfully answer the following Challenge Problems. Carefully read and perform all the steps with your own microcontroller.
   * + **Intermediate students:**
       - **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
         * xxx. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
         * xxx.
       - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.
     + **Intensive students:**
       - **You should be *able* to solve all of the following Challenge Problems. However, you are only *required* to turn in the highlighted and underlined problems below, which will be graded.**
         * xxx. Record your answers on the Predictive Worksheet and turn in this work to your teacher.
         * xxx.
       - Turn in your work to be graded by outputting your coded solution as a PDF and turn it in via a Canvas Assignment on the LMS. Once your work has been handed in, you may proceed to the next chapter.

## E.1.30. Independent Project!

1. With luck and hard work, you have arrived at this point by the beginning of Term 3. Apply all of what you learned during the first two terms and work on your final independent project.
2. Instructions xxx