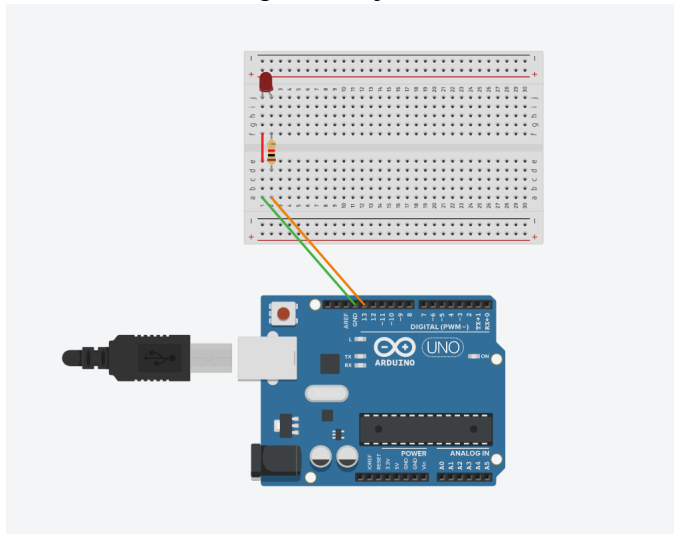# LAB REPORT 04

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Screenshot + components:

- No new components, just arduino, resistor, code and led

Summary:

In this lab, I learned how to program the I/0 pins by manipulating their memory addresses. The first part required me to use the library functions and the given displayRAM function to set pin 13 as output and set as HIGH and then display the memory locations 0x20 to 0x2f. I then had to do the same, but setting pin 13 to LOW. All of these things were done in one function. I saw that there were no 20's when I displayed the RAM before manipulating the addresses. After setting it to HIGH, 3 20's appeared. When setting it to LOW, there was only one 20 left. The effect of doing that code was that the led light flashed on and off. The next part of the lab was basically doing the same thing, but without the library functions. I first set a pointer to the address that I was going to manipulate based on the previous RAM displays. Then I dereferenced it and read the byte/content. This byte was then flipped by using exclusive or (^) on the previous dereferenced pointer. Lastly I made a delay of 1 second. This was all done in one function and called in the loop.

Results:

first part:

```
Starting...

020: 00 00 00 00 00 00 00 00 00 01 00 00 00 00 00 00

020: 00 00 00 20 20 20 00 00 00 01 00 00 00 00 00 00

020: 00 00 00 00 20 00 00 00 00 01 00 00 00 00 00 00
```

For the second part, nothing happened with the LED lights. I think I may have used the wrong address. Based on the Standard IO Registers map I thought I was supposed to use 0x22. I don't know what the issue was.

Conclusions:

1. You can control things like LED lights by manipulating the proper pin's address.
2. Arduino has library functions that make it very easy to set pin addresses. You can also do the same operations without the given functions as well.
● The major issue that I had was the second part. My code seemed to look correct, but for some reason it did not do what it was supposed to. I am assuming that I was using the wrong address, but it could have been something else as well.

Code:

```
/*
 Memory Mapped I/O Exploration
 */

/* Figure out what bits control pin 13. make use of the provided functions
*  to do this.
*/
void setup() {
  // Setup for Serial output
  Serial.begin(9600);
  Serial.println("Starting...\n");
  setupFunct();
}

/*once you know which bit can be used to turn pin 13 on and off,
* try to blink an led in loop without using digitalWrite().
*/
void loop() {
  manualBlink();
}

void manualBlink() {
```

```cpp
  // HIGH byte address
  char *addr = (char *)0x22;
  // get the byte
  char byte = *addr;
  // bitwise exclusive or
  *addr = byte ^ *addr;
  delay(1000);
}


/* setup function */
void setupFunct() {
  // display 0x20 to 0x2f
  char *start = (char *)0x20;
  char *end = (char *)0x2f;
  displayRAM(start, end, true);

  // set pin 13 as output & HIGH & display ram
  int pin = 13;
  pinMode(pin,OUTPUT);
  digitalWrite(pin, HIGH);
  displayRAM(start, end, true);

  // set pin 13 to LOW & display ram
  digitalWrite(pin, LOW);
  displayRAM(start, end, true);

}


/* example call displayRAM((char *) 0x8E0, (char *) 0x8FF, true);
 * if hex is false, letters and numbers will be printed, and all other values will be represented as '.'  */
void displayRAM(char *start, char *endd, bool hex) {
  char *array;
  for(array = start; array < endd; array += 0x10) {
          //create row number
          if (array < (char *)0x10)
          Serial.print('0');
          if (array < (char *)0x100)
          Serial.print('0');
          Serial.print((int)array, HEX);
          Serial.print(": ");
          //for each index (0 through 15 inclusive)
          for(int i = 0; i < 0x10; i++) {
          if(hex) {
          if (array[i] >= 0x00 && array[i] < 0x10)
          Serial.print('0');
          Serial.print(array[i] & 0xFF, HEX); //0xFF is our bitmask
          } else {
          Serial.print((array[i] >= ' ' && array[i] <= 'z') ? array[i] : '.');
          }
          Serial.write(' ');
```

```
        }
        Serial.println();
    }
    Serial.println();
}

//Example call displayBits((char *) 0x100);
//pretty prints an address in binary
void displayBits(char *address) {
    Serial.print("0x");
    Serial.print((int) address, HEX);
    Serial.print(": ");
    Serial.println(address[0], BIN);
}
```

Rubric:

Each lab is graded out of 10. Labs are due at midnight a week after they are assigned. Labs turned in late receive a max of 7 points:

Item	Points worth
Code correctness	3
Submission form correct	3
Report contains accurate information	2
Some effort put into report*	2

*No answer is too short to properly address the lab report section and I can tell you tried at least just a little.