

Problem 1 – Number systems and operators

Determine the output of each expression. Write the value stored as both an 8 bit binary number and as a signed char decimal number.

char x = 50 + 50;

Value stored in binary

01100100

100

Decimal value if printed

char x = 100 + 100;

Value stored in binary

11001000

-56

Decimal value if printed

char x = -10;

Value stored in binary

11110110

-10

Decimal value if printed

char x = 44 / 5;

Value stored in binary

00001000

8

Decimal value if printed

char x = 16 * 16;

Value stored in binary

00000000

0

Decimal value if printed

char x = 30 % 7;

Value stored in binary

00000100

2

Decimal value if printed

char x = 15 ^ 2;

Value stored in binary

00001101

13

Decimal value if printed

Problem 2 - Binary

Assume that you have a variable called a **decabit** that is a signed 10 bit number. What is the largest and smallest value that you could hold in a signed **decabit**?

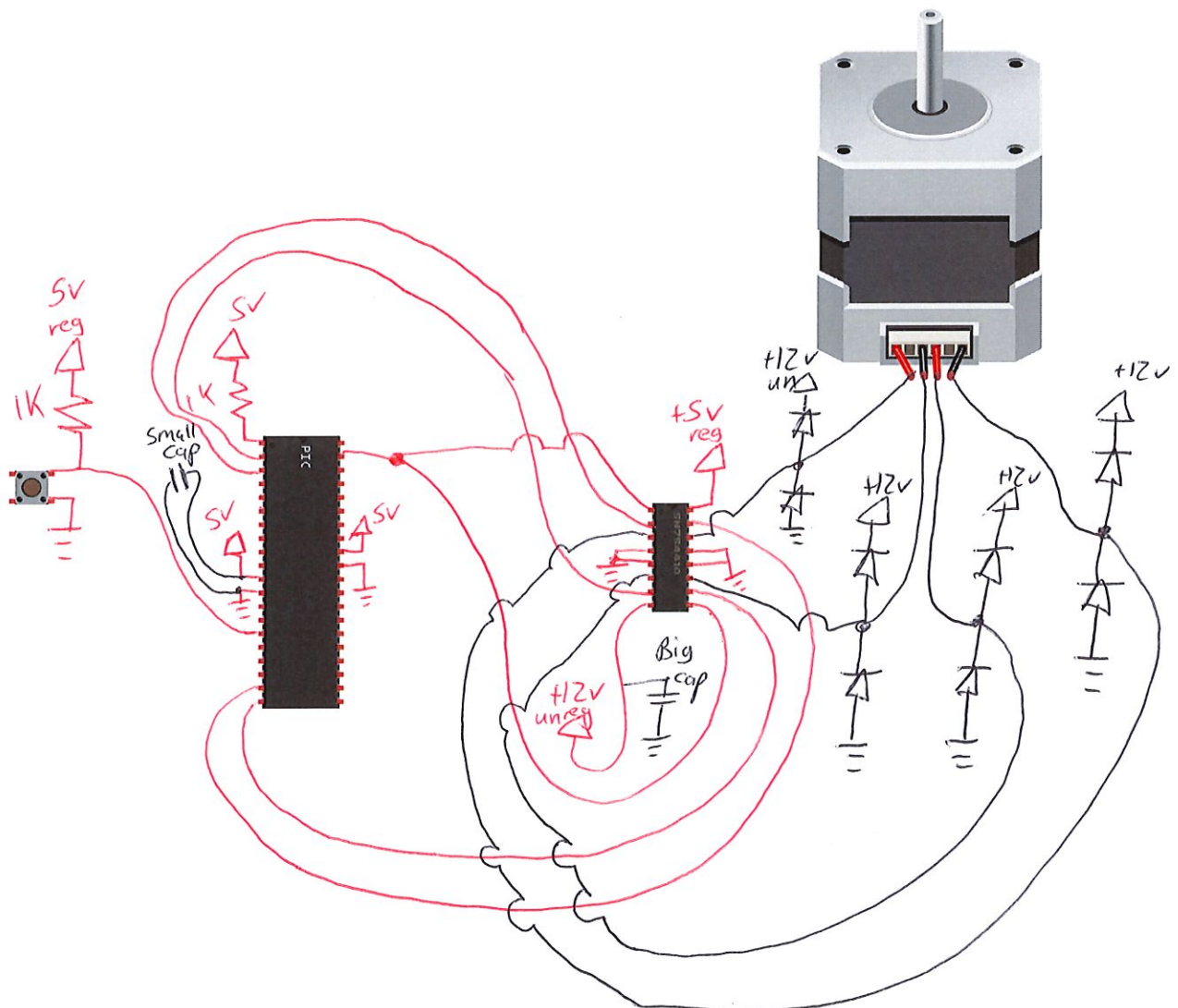
-512

511

Problem 3 - Stepper Motor

Use the components shown below to connect a stepper motor circuit.

- Assume you want to drive the stepper at 12v and you have an unregulated 12v power supply available (just write +12v unreg next to any power symbols you add below)
- Set up a basic switch circuit with the pushbutton, and connect the signal line to RC0. Pretend like the PIC is already programmed and pushing the button will cause it to spin 3 laps (or something like that).
- Connect the PIC as needed (assume it is already programmed just needs to run)
- Connect the PIC to the H-bridge as follows:
 - RA0 and RA1 are a pair and need to drive one side of the H-bridge
 - RD0 and RD1 are a pair and need to drive the other side of the H-bridge
 - RB6 is a signal that can enable/disable the H-bridge
- Connect other H-Bridge pins as needed to drive the stepper at +12v
- Add snubber diodes, decoupling capacitors, and any necessary resistors for the circuit (size all resistors and label values, sizing capacitors is not required).



Problem 4 – BJT resistor sizing

Assume you have a 9 volt battery, voltage regulator, motor with a 96 ohm resistance, BJT, and PIC microcontroller. Draw the circuit connections below to drive the motor using the 9 volt battery. Add resistors, snubber diodes, and capacitors as needed. Assume the PIC is programmed to control the motor using RB0. For the resistor to the BJT show your work for calculating the resistor size and put your resistor value in the boxes below.

Motor current

$$V = I R$$

$$9 = I \cdot 96$$

$$I = 0.09375 \text{ A}$$

BJT current

$$I = 0.009375$$

Res Size

$$V = I R$$

$$5 = 0.009375 R$$

$$R = 533 \Omega$$

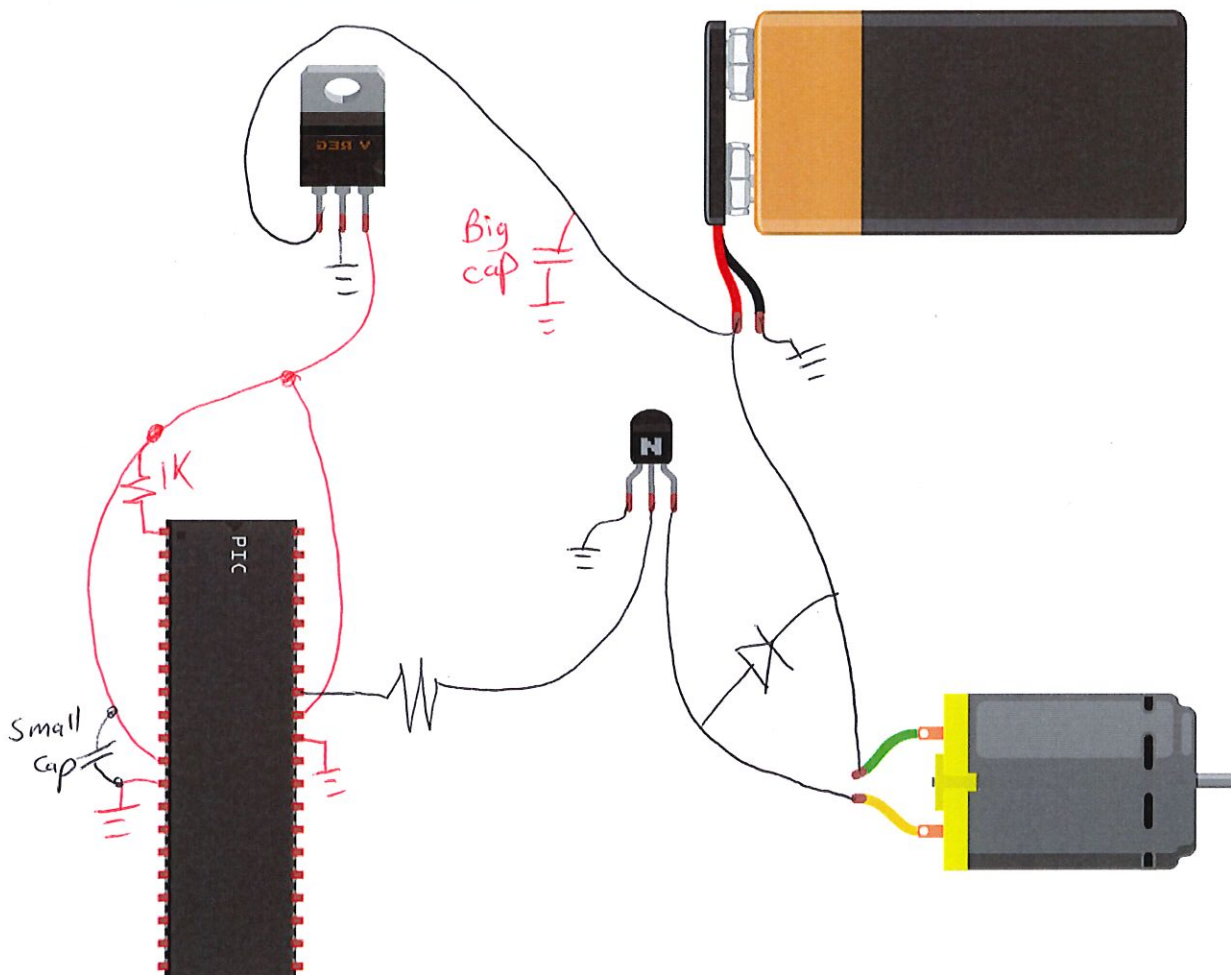
Exact BJT resistor value calculated

533 Ω

Real BJT resistor value

560 Ω

470 Ω
is ok
I guess



Problem 5 – C debugging

Consider the code scrap shown below.

```

#include <stdio.h>

void main(void)
{
    int i;
    int x = 0;

    for (i = 0; i < 10; i = i + 2) {
        x = x + i;
        if ((x) = 8) {
            fprintf("Getting big!\n");
        }
    }
    fprintf("x = %d\n", x);

    while (1) {
    }
}

```

Bonus point

SEMANTIC should be an i not an x

SYNTAX missing {

SEMANTIC <=

SYNTAX needs ;

SEMANTIC ==

SYNTAX just printf

- This code contains syntax errors and won't compile. Mark each syntax error mistake with an arrow, label it as **SYNTAX**, and indicate how it should be fixed. Note: only fix things that would cause the program to crash in this step.
- Additionally the code contains mistakes that make the code run incorrectly. They are not syntax errors that cause a crash, but they cause not to run as intended. The intended goal of this program is to add up $0 + 2 + 4 + 6 + 8$ (print "Getting big!" at 8) + 10 and then print $x = 30$, but that won't happen even after the syntax errors are fixed. Mark each semantic error with an arrow, label it as **SEMANTIC**, and indicate how it should be fixed.

```

/** Header Files *****/
#include <stdio.h>

/** Define Constants Here *****/
#define FAVORITE_NUM 7
#define LIST_LENGTH 9

/** Global Variables *****/
int number_list[LIST_LENGTH] = {19, 21, 7, 55, 8, 7, 22, 42, 13};

/*****
 * Function:      void main(void)
 *****/
void main(void) {
    int i;
    int value;
    int count = 0;
    printf("\n\n");
    for(i = 0; i < LIST_LENGTH; i++) {
        value = number_list[i];
        if (value % FAVORITE_NUM == 0) {
            printf("%d is divisible by my favorite number\n", value);
            if (value == FAVORITE_NUM) {
                count++;
            }
        }
    }
    printf("The number list contains my favorite number %d times\n", count);

    while (1) {
    }
}

```