Name _____ $SOLN$ _____

1. (3 points each) True/False (circle your choice):

a. T **F** The microprocessor register that holds the address of the next instruction to be fetched from Program Memory is called the Stack pointer.

b. T **F** The assembly language instruction ADDLW BYTE1 is an example of the direct addressing mode.

c. **T** F In the indirect addressing mode, the address of the operand is specified in a File Select Register.

d. **T** F Conditional branch instructions use relative addressing, by adding a signed offset to the Program Counter.

e. T **F** The assembly language instruction TBLRD*+ copies data from the File Memory to the Table Latch, then increments the Table Pointer.

2. (15 points) Perform the following signed addition using 8-bit two's complement arithmetic and verify your answer in base 10. Indicate the final value of the 5 Status flags.

$$C4_H + 27_H = \underline{EB}_H$$

$$C4_H$$
$$+\ 27_H$$
$$\overline{EB_H}$$

$$1100\ 0100 = -(0011\,1100) = -3C_H$$
$$+\ 0010\ 0111$$
$$\overline{1\,1110\,1011} = -(0001\,0101) = -15_H$$
N

N OV Z AC C
1   0   0   0   0

Base 10
$$-3C_H = -(3\times16 + 12) = -60_{10}$$
$$+27_H = (2\times16+7) = +39_{10}$$
$$\overline{-15_H} = -(1\times16+5) = -21_{10}\ \checkmark$$

3. (6 points) List three typical support devices included on the MCU chip.

Timers

A/D Converter

Serial Communications

4. (6 points) What is the memory capacity of a 24-bit address bus? How many address lines would be required for a 32K memory?

$$2^{24} = 2^4 \cdot 2^{10} \cdot 2^{10} = \underline{16\ MB}$$

$$32k = 2^5 \cdot 2^{10} = 2^{15} \Rightarrow \underline{15\text{-bit Address}}$$

5. (6 points) List the two categories of registers and their full (12-bit Hex) address ranges that are included in the access bank.

Access Bank   000

GPRs   07F

SFRs   F80 / FFF

6. (6 points) What is the Hex machine code for the following assembly language instructions:

IORLW   0xF8

0000 1001 kkkk kkkk
1111 1000

$$\underline{0\quad 9\quad F\quad 8_H}$$

BSF   f,b
     7,5

1000 bbba ffff ffff
1010 0000 0111

$$\underline{8\quad A\quad 0\quad 7_H}$$

7. (12 points) Identify the contents of WREG, REG2, and the status of the flags as the following instructions are executed by the PIC MCU.

		WREG	REG2	N	Z	C
		73	CA	0	0	1
MOVLW	0xF0	FO	CA	0	0	1
ANDWF	REG2,F	FO	CO	1	0	1
INCF	WREG,W	FI	CO	1	0	0
SWAPF	REG2,W	OC	CO	1	0	0
CLRF	WREG	OO	CO	1	1	0

8. (14 points) Draw a flowchart for a program that adds two arrays of numbers (both in Data Memory). The arrays are the same size and the number of elements is given (N). Include a diagram of the registers and memory used by the program.
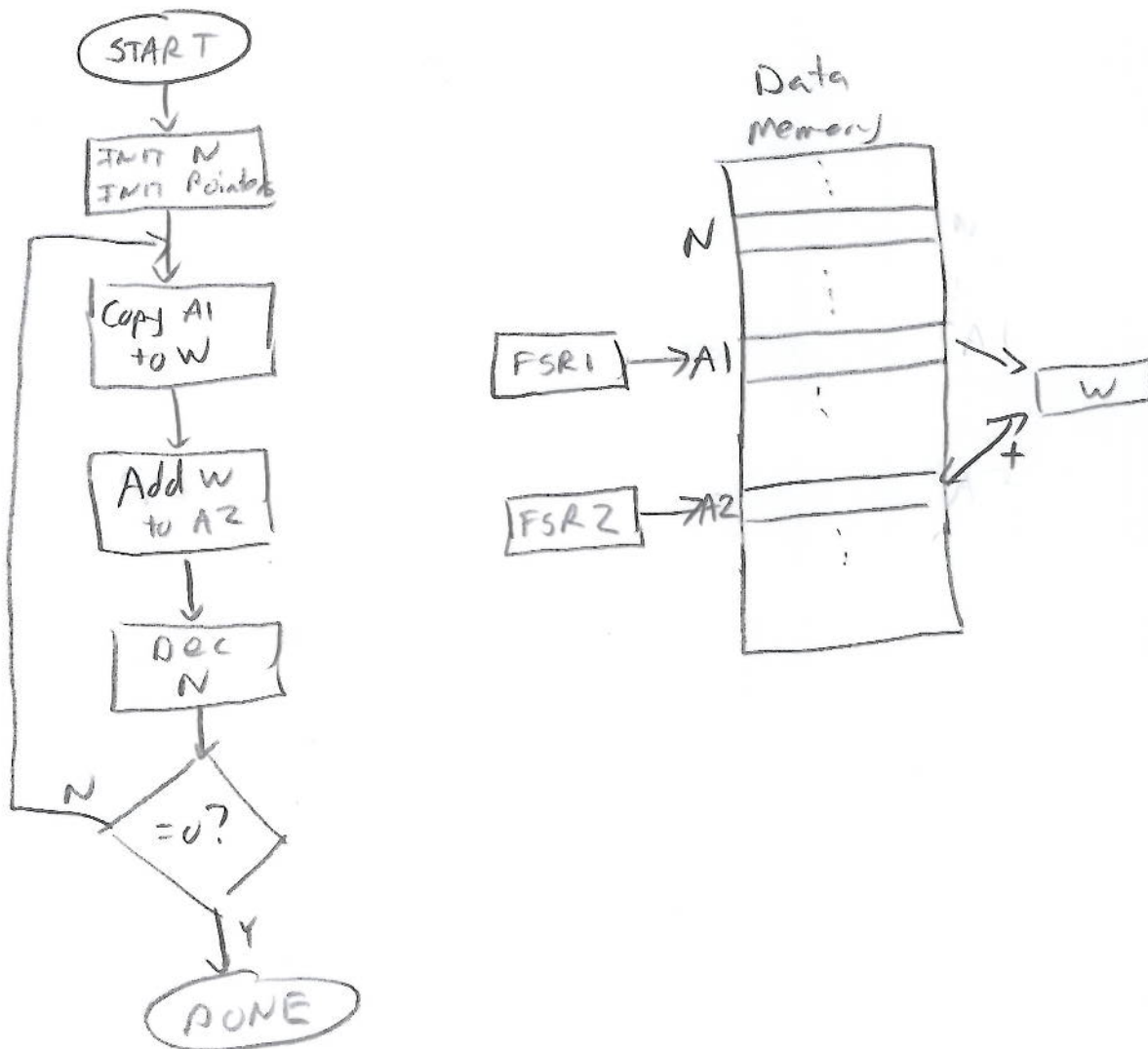
9. (20 points) Write an assembly language program for the following flowchart (which implements N3 = |N1 - N2|). Include appropriate assembler directives to start your program at 40_H and include sample test data.

Start

Load N1 and N2

Subtract

Negative?   N

Y

Negate

Save

Done
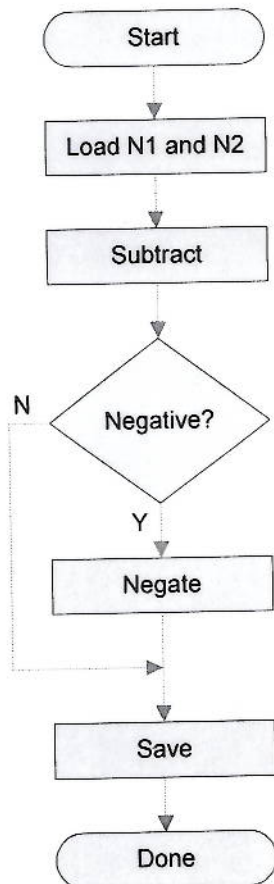
```
BYTE1    EQU    5
BYTE2    EQU    7
N1       EQU    1
N2       EQU    2
N3       EQU    3

         ORG    0
         GOTO   START

         ORG    0x40
START:   MOVLW  BYTE1  ; Load N1, N2
         MOVWF  N1
         MOVLW  BYTE2
         MOVWF  N2
         SUBWF  N1,W   ; Subtract
         BNN    SAVE   ; Negative?
         NEGF   WREG   ; Negate
SAVE:    MOVWF  N3
         SLEEP
         END
```